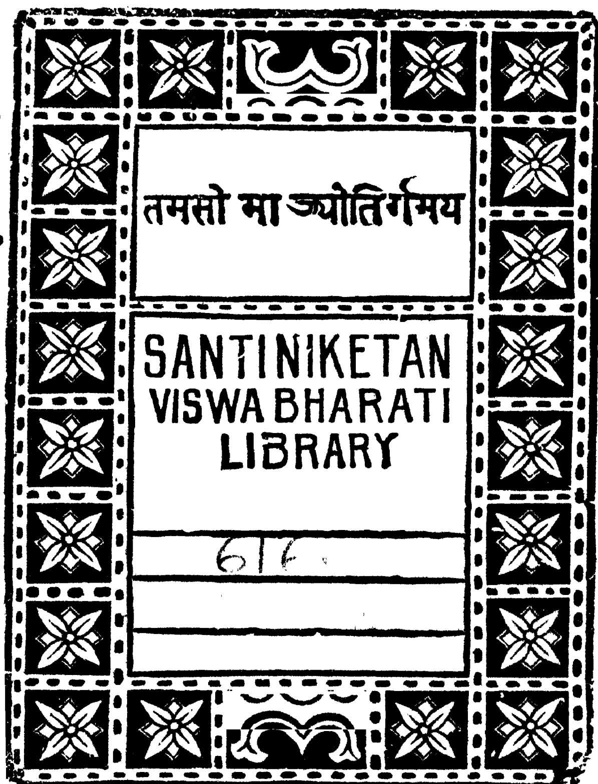


DIABETES MELLITUS
AND ITS
DIETETIC TREATMENT

BY

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TO THE REVERED MEMORY

OF

MY BROTHER

ai Bahadur Srisa Chandra Vidyarnava

PREFACE TO THE FIFTEENTH EDITION.

It has not been convenient or expedient for some of my critics to admit that the expression "Pre-glycosuric stage, now made use of by several investigators of the subject, was first suggested by me, and so also the use of the vitamins in Diabetes which in some instances is a deficiency disease. The use of oleaginous seeds and ground nut in Diabetes was for the first time described in this little book. The view of the spleen being an Endocrine gland and its influence in the production of Glycosuria now held by many scientists, was originally given expression to by the present writer.

These facts were mentioned in the preface of the previous editions, yet no notice was taken of these by those who indulged in destructive criticism.

My paper on "some observations on the proper cooking of Dals" which was given the place of honour in December 1896 issue of the *Indian Medical Gazette* showed, for the first time, the manner in which the people of India cook *dals*, which natives of other countries find difficult to do. Some twenty years after the publication of the above-mentioned paper of mine, a memoir, entitled "Some Factors affecting the cooking of Dall" was published by the Deparatment of Agriculture of India, (Chemical Series) which while confirming my observations, curiously enough, made no reference to my paper on the subject.

My son, Dr. Lalit Mohan Basu M. B. (Cal.) has revised it and brought it up to date, and has added a glossary of medical terms to make them intelligible to non-medical men. This improved edition, it is hoped, will be found useful as the previous ones.

ALLAHABAD : B. D. BASU.

2nd January 1930.

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WHAT IS DIABETES MELLITUS ?

The Hindu physicians of ancient India were the first in the world to diagnose what is called Diabetes Mellitus, which consists in voiding a large amount of urine containing excessive quantities of sugar and nitrogen and sometimes of acetone. It is not a specific disease. Structural lesions of the pancreas, the liver, the ductless glands or some portion of the nervous system have been known to be associated with this disorder. But how this is brought about is not clearly understood.

Had we known the true pathology of Diabetes Mellitus, we should have been, perhaps, in a position to treat it more properly than we can at present.

But if we regard Diabetes Mellitus or glycosuria as not a disease by itself, but a manifestation of several pathological or functional changes in one or more organs, we shall be in a position to under-stand its true significance. Glycosuria, like fever or

pyrexia, should be considered as a symptom, and, as in fever, the aim of the physician is not so much to reduce the high temperature as to cure the disease of which pyrexia is one of the symptoms; so in Diabetes Mellitus the physician should not rest content with merely trying to reduce the quantity of sugar in the urine, but to treat the condition or conditions of which it is a product.

The nature of sugar in the blood.

The Sugar normal to the blood is an unstable form of dextrose, possibly *r*-dextrose or ordinary *d*-glucose.

In normal persons blood sugar varies within the limits of 0·08-0.11 per cent; it is seldom higher than 0·11 or lower than 0·07 per cent.

Conditions leading to Glycosuria.

In a paper on Experimental Glycosuria, read before the 69th Annual Meeting of the British Medical Association, held at Cheltenham in July and August, 1901, and afterwards published in the *British Medical Journal* for October 12, 1901, the late Dr. Pavy mentioned the following conditions as producing glycosuria:—

Bernard's puncture of the floor of the fourth ventricle, extirpation of the superior cervical sympathetic ganglion, of the first thoracic ganglion, and division of the thoracic

sympathetic chain (Pavy); extirpation of the cœliac plexus (Klebs and Munck); section of the medulla spinalis on a level with the brachial plexus (Pavy); stimulation of the central end of the cut vagus (Bernard); stimulation of the depressor nerve (Filehne); section and stimulation of the sciatic nerve (Schiff).

The administration of phosphoric acid (Pavy); lactic acid (Goltz); hydrochloric acid (Naunyn); uranium salts (Cartier, Chittenden); potassium cyanide (Frerich); phosphorus (Araki); chloral and chloralamid (Feltz and Ritter, Manchot); nitrobenzol and nitrotoluol (Ewald, Magnus-Levy); nitro-phenyl-propiolic acid (Hoppe-Seyler); phloridzin (v. Mering); thyroid extract (Dale-James); strychnine (Sciffh); methyldelphinine (Reshop); morphine (Bernard); caffine (Jatcobi); curara (Bernard); carbon monoxide (B. W. Richardson); nitrous oxide (Lafont); amylnitrite (F. A. Hoffmann); respiration of oxygen (Pavy): excessive aeration (Pavy); chloroform and other inhalation; partial mechanical asphyxia (Pavy); partial asphyxia by restricted supply of oxygen; restraint glycosuria of cats (Bohn and Hoffmann) and of frogs (Velich); intravenous and subcutaneous injection of sugar (Bernard); excessive ingestion of sugar (Pavy). Worm-(Muller); re-absorption of sugar from mammary gland—lactosuria (Blot); excision of the pancreas (di Dominicis. Minkowski): ligation and fistula of the thoracic duct (Biedi).

To the above long list may be added the production of glycosuria by the administration of heavy metals, such as by Zinc Salts, which is probably of renal origin.

Dr. Pavy said—

"With such a chaotic list before us it is difficult to

see upon what ground we stand with respect to the manner in which the several conditions act in producing glycosuria."*

The introduction into the system of any toxic agent of mineral, vegetable or bacterial origin gives rise to glycosuria. Hence, no surprise need be felt at the chaotic list mentioned above if we look upon the production of sugar in the system as an effort of Nature to get rid of the deleterious effects of poisons and thus to serve the purpose of an antidote.†

Classification of Glycosuria.

Glycosuria may be classified as regards the conditions leading to its production as follows :—

I. **Simple,** occurring by taking a large quantity of Saccharine or Carbo-hydrate stuff.‡

*Rosenberger has attempted to classify the chaotic list of poisons as renal, hepatic, neurotic, respiratory and finally those whose mode of action cannot be determined.

†See Sir W. Wilcox's paper on Toxic factor in Disease with special reference to chronic Rheumatic conditions and Diabetes ; Indian Medical Gazette, September 1925, p p. 439—40.

‡Thus according to Age Th. B. Jacobson, of Copenhagen, (*Chem. Abstr.*, March 20, 1914, p. 1144)—

"Ingestion of large amounts of Starch or Sugar can

II. Alimentary—In which some portion of the Alimentary System or organs concerned in metabolism is at fault. There is very often some disorder of the stomach.*

Chronic Duodenitis is said to cause diabetes.†

Affections of the Liver,‡ the Pancreas, the Spleen, the tonsils and pharynx often cause Glycosuria.

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cause an increase to 0. 16 – 0. 17°/. (of Sugar in the urine) in normal persons. The increase is more rapid and likely to be greater after consumption of sugar than after that of starch."

*I.—Dietrich has examined the gastric juice of 40 cases of diabetes and found normal conditions only in 25°/. There was severe gastric catarrh or achlorhydria in 67°/. The sugar disappeared completely from urine in 3 out of 9 cases of diabetes in which lavage of the stomach was practised without enforcing an antidiabetic diet. There is much to indicate that more than one organ concerned in the metabolism of carbo-hydrates must be involved in the causation of diabetes, that the pancreas is not the one to be affected first.'—*Chem. Abstr.*, June 10, 1914, p. 1980.

†To the *Practitioner* for May, 1915. Dr. N. Mutch contributes a paper in which he brings forward evidence to show that chronic duodenitis is the determining factor in the production of Diabetes Mellitus.

‡ Drs. Marcel Labbe and Ambroise Bonchage of Paris (*The Lancet* for Jan. 3, 1914, pp. 13-15) have considered

The importance of the hepatic function will be understood when it is remembered that the liver destroys poisons of all kinds, whether inorganic, organic or biochemic produced in the body. Whenever there is hepatic incompetency, poisons are not destroyed and so sugar in the blood is brought into existence to counteract the deleterious effects of poisons as far as possible.

At the post-mortem examinations of patients dying of Diabetes, in some the pancreas has been found undersized, while in a few deteriorated.

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the question of hepatic diabetes and are of opinion that—

"Hepatic diabetes supervenes, as a rule, in heavy eaters. It is preceded often by obesity, sometimes by gout or renal lithiasis.........

"The cause of this hepatic diabetes may be general infection that attacks the liver, an intoxication such as by alcohol, which has an affinity for liver cells. More often, according to our observations, it is due to over-feeding especially on meat."

In the B. M. J. of March 11, 1922, p. 420, Dr. T. Houghton Mitchell draws the attention of its readers to the efficiency of Ammonium chloride in glycosuria of the hepatic origin. He says that given in full doses three times a day before meals, combined with taraxacum, compound spirits of Ammonia, and Nux Vomica, it speedily reduces the sugar content and produces a rapid fall in the specific gravity of the urine.

But a good normal pancreas is, by no means, a rare thing in Diabetes.

III. Toxæmic.—Phloridzin, chloroform, epinephrine, dyspnœa and other poisons mentioned above by Dr. Pavy are known to cause glycosuria.

But, according to my observation, it is alimentary toxæmia, which causes glycosuria in a very large number of cases.

IV. Affections of Glycogenic centres.—Thus tumors of the floor of the Fourth Ventricle cause glycosuria.

V. Affections of the Nervous system.

VI. Functional or Emotional.—Messrs O. Folin, W. Denis and W. G. Smillie of Boston,

" found sugar in the urine of 22 insane patients out of a total 192. Of the 22, the majority suffered from depression, apprehension or excitement. More direct evidence of the existence of emotional glycosuria in man was obtained by testing for sugar in the urine of students before and after important examinations. Of 33 students, 6 or 18% had traces of sugar in the urine passed

immediately after the examination. It seems reasonably certain from the results obtained that pronounced mental and emotional strain may produce temporary glycosuria in man."—(Chem. Abstr. for Aug. 10, 1914, p. 2742, from J. Biol. Chem.)

VII. Influence of the Ductless Glands.—Affections of the ductless glands, such as of the thyroids, as in exophthalmic goitre, of the pituitary body, as in acromegaly, of the Adrenals, of the female organs of generation, as in ovarian tumors, as well as of Parathyroids, are known to cause glycosuria.

The Spleen is a ductless gland, and so its affections also cause glycosuria. Splenic glycosuria has not been laid stress upon by investigators in the West, since affections of the Spleen are comparatively rarer in Europe than in India.

Believers of the Endocrinological influence in the human system think that adrenaline like the β cells of the islets of Langerhans of the Pancreas plays an important part in the carbo-hydrate metabolism.

Beaumont and Dodds in the Recent Advances of Medicine P. 86, write:—

"An injection of adrenaline gives rise to glycosuria. An action of the hormone is said to lie in the fact that it stimulates the liver to break down glycogen, with the result that hyperglycæmia and glycosuria ensue."

VIII. Influence of age and sex.—There is *Diabetes Innocens* of younger individuals, in which, as a rule, the excretion of sugar in the urine remains below one per cent, while there exists a pronounced, although not absolute, independence from the diet.

There is often glycosuria present in pregnant women. Diabetes has been noticed in bearded women.*

In the aged, there is glycosuria, said to be due to arteriosclerosis.

IX. Syphilis and Diabetes.—Syphilis is often responsible for many of the affections of the

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******New York Medical Journal* **for May 18th, 1921, p. 36, "Diabetes, whether mild, severe, or grave, is due to endocrine disturbances, as is hirsuties itself, and is, perhaps, also of adrenal origin."**

Pancreas leading to diabetes. Modern "civilization" has been called by some cynical writers of the occident, "Syphilisation." Sexual excesses perhaps account for the prevalence of Diabetes in civilised countries. It is, therefore, necessary to apply Wasserman's test in every case of diabetes in a resident of a "civilised" country to find out the existence of latent syphilis in him. Conjugal diabetes is probably due to this latent syphilis in both husband and wife. This may perhaps also explain the heredity of Diabetes.

X. **Septic conditions and Glycosuria**—Sugar is often noticed in the urine when one suffers from carbuncles, boils or some other septic affections. Dr. Prout was the first to draw attention to this. This has been noticed by other observers also.*

* In an interesting paper in *B. M. J.* February 26, 1921, on Sapræmic Glycosuria. Dr. Charles Gaskell Higginson says :—

"I believe that carbuncle or gangrene secondary to diabetes is not very common......"

He concludes his paper by saying :—"As the sapraemic products of gangrene, carbuncle, erysipelas, etc., differ considerably from each other, it is probable that one sapræmia willdiffer much from another in its power of lowering the saturation point of sugar. At present gangrene and carbuncle are the most striking and misleading agents in the causation of sapræmic glycosuria,

XI. Renal Diabetes*—Regarding this form of diabetes, Carl Von Noorden writes :—

"1. There are certainly kidney disorders which hinder the passage of sugar into the urine.

"2. There is an experimental form of diabetes dependent upon abnormal permeability of the kidneys. Phloridzin diabetes is of this nature, and possibly other toxic glycosurias also.

"3. The existence of renal diabetes as an independent disease has not yet been proved."

"In case of (renal) diabetes there was least glycosuria on a liberal carbo-hydrate diet. Milk diet, rest or exercise caused no change : and the sugar content of the urine was independent of carbohydrate supply. The proportion of sugar in the blood was subnormal and independent of the food. —From this and other cases, it appears that the existence of a clinical renal diabetes is establish-

but further investigation will doubtless reveal a long series of such agents differing from each other very much in the power of causing sapræmic glycosuria."

* According to T. Itakura, a Japanese investigator, there is an internal secretion of the kidney and its influence in regulating the sugar content of the blood.

ed and it differs from diabetes mellitus in cause, course and prognosis."*

It is, therefore, necessary to examine the blood for sugar ; for the sugar content of the urine does not give a true index of its amount in the blood.

I restrict the term **Diabetes Mellitus** to that form of glycosuria which is consequent on alimentary toxæmia.

Pre-glycosuric or Pre-diabetic stage.†

By studying the history of diabetic patients in India, we know that they show certain symptoms before the discovery of sugar in the urine. I call this stage—PRE-GLYCOSURIC OR PRE-DIABETIC.

In some, the symptoms are those of what is vaguely termed Indigestion or Dyspepsia. Constipation is an early symptom ; another is burning sensation of the hands and feet. Some suffer from polyuria or nycturia. Dilatation of the stomach may be observed in many. If the mouth

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**Chem. Abstr.* for April 20, 1914, p. 1456, from C.. D. De Langen's paper in *Nederlandsch Tijdchrift Voor Geneeskande,* 2 No. 17, 1443, through *Jour. Am. Med. Assoc.* 62, 739-740.

† The term "preglycosuric stage,' first suggested by me, has been adopted by some recent investigators.

is carefully examined, oral sepsis, such as pyorrhœa alveolaris is discovered in not a few. The terminal end of the alimentary canal shows also, not unfrequently, the existence of piles. Hydrocele is also very often present. Obesity also is not a rare occurrence. Many diabetic patients give the history of their having suffered from malaria, and consequently enlarged spleen. Affections of the skin, pruritus, falling off of the hair and teeth are also some of the symptoms. There is often arterial tension or high blood pressure. This occasionally causes arterial spasm producing convulsions. In India, everyone after 40 years of age should be often examined with sphygmomanometer for measuring blood pressure.

The pre-glycosuric stage deserves very careful attention at the hands of Indian practitioners ; for much can be done to prevent the occurrence of diabetes, if the patient be properly treated at this stage.

Detection of Sugar in the pre-glycosuric stage.

In this stage, sugar cannot be detected in the urine. But that does not mean that the sugar content of the blood is not above normal. In India,

in all cases of dyspepsia, it is expedient to examine the blood for sugar, to find out whether those cases are likely to end in diabetes.*

How to differentiate cases of non-diabetic from true diabetic glycosuria.

"As the essential difference lies in the fact that a diabetic patient is unable to use surplus sugar in the organism, Adis based his test upon the result of administering increasing quantities of glucose on four successive days, and noting the result upon the urine. The test is carried out as follows : on the first day, 20 oz. of water are taken by the patient in the morning fasting, and exactly two and four hours later he passes the urine into two separate bottles ; on the second day, a similar procedure is carried out, but in addition 25 grms. of glucose are taken with the water ; on the third day, 50 grms. are thus taken ; and on the fourth, 100 grms. The urine of cases diagnosed as non-diabetic glycosuria either showed no increase at all in

*Dr. Otto Folin very truly said :—

"There is in my mind not the slightest doubt that by means of chemical investigation of blood, clinical problems of many kinds will be elucidated to a much greater extent than has been possible by means of urine analysis, though the two must go hand in hand."

glucose after even 100 grms. had been administered or at most showed only a trifling rise to 2·5 grms. or thereabout; while the urine of cases diagnosed as diabetic showed, when the larger amounts of glucose were taken, a great increase amounting to as much as 25 or even 49·7 grms. The writer found that the reliability of the test was proved by the subsequent progress of the cases."—*Medical Annual* for 1918, p. 152.

Glycosuria—a manifestation of alimentary toxæmia.

By the analysis of symptoms and so called complications of diabetes, we shall not, perhaps, be wrong in considering it in most cases as a manifestation of alimentary toxæmia. To my mind, it explains the occurrence of diabetes much better than any theory so far advanced. Of course, the nature of the toxin, is not yet properly known. One of the earliest symptoms of diabetes is said to be cramps in the calves of legs. This is due to alimentary toxæmia.

Again, eczema, psoriasis, boils, carbuncles and some other skin diseases, as well as cataract.* said

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*It has been experimentally shown that cataract is due to Vitamin deficiency. In the *Chemical Abstracts* Vol. XIX. No. 13, July 10, 1925, (p. 20 66), it is stated :—

to be so many complications of diabetes, are manifestations of alimentary toxæmia.

Several diseases are grouped as allied ones with diabetes. These are also manifestations of alimentary toxæmia.

How is alimentary toxæmia brought about?

Alimentary toxæmia is brought about by—

I. Errors in diet.

II. Disordered conditions of the digestive juices.

III. The toxins discharged by the bacteria in the alimentary canal.

1. **Errors in diet**—When the quality of foodstuffs cousumed is not good, it is known to produce toxic symptoms. Wheat and rice form the staple articles of food of the population of India.

As regards wheat, we have the high authority of Sir William Crookes, who in his presidental address at the British Association for the Advancement of Science in 1898, said that no other grain can take the place of wheat in the preparation of bread—the staff of life for man.* But with the

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"Cataract formation is ascribed to the lack of a new Vitamin characterized as "Factor Z".

*Sir William Crookes said :—

"We are born wheat-eaters Other races, vastly superior

export of wheat, the people of India, for the most part, have, to depend on inferior food-grains for their bread.

The export of wheat obliges people to maintain themselves on inferior and unwholesome food-grains. The injurious effects of this cannot be disproved by sophisticated arguments. Steps should, therefore, be taken to reduce, if not actually to stop, the export of wheat.

Again, the roller process of milling wheat is objectionable, since it deprives this cereal of some of its most important constituents. The evil is carried to excess by the bleaching of the flour.

Rice forms the staple article of diet, if not of the majority, at least of a very large population of India. In polished rice, the vitamin is got rid of, and thus its consumers do not get that nutriment which they would otherwise derive from it.

Moreover, the Bengali mode of preparation of

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to us in numbers, but differing widely in material and intellectual progress, are eaters of Indian corn, rice, millet and other grains; but none of these grains have the food value, the concentrated health-sustaining power of wheat, and it is on this account that the accumulated experience of civilised mankind has set wheat apart as the fit and proper food for the development of muscle and brains."

rice is open to the objection that salts are removed by throwing away the water in which rice is cooked.

Pure milk and *ghee*, which enter so largely into the Indian dietary, cannot be had in large towns in India, in sufficient quantities to meet the requirements of the people. There is, moreover, no article of diet which is not more or less adulterated.

The practice of adding preservatives to food-stuffs, which are thus made unwholesome, should be strongly condemned. People should take fresh foods and not preserved or tinned food-stuffs, for, in their canning, vitamins are destroyed by heating them.

Tea-drinking, which has been introduced in recent years in India, is a very fertile cause of dyspepsia, leading to alimentary toxæmia. So also is the taking of ice and its preparations in the causation of dyspepsia.

It is the belief of many that diabetes has been prevalent in this country since the introduction of the potato. There may be some justification for this belief, if we remember the fact that the potato contains the poisonous alkaloid and glucoside known as *solanin*. Consumption of potatoes in

large quantities disturbs the digestive system and thus gives rise to alimentary toxæmia.*

In some parts of India, such as East Bengal, the eastern and western coasts of the country and Rajputana, chillies are used to such an extent that their influence on digestion is detrimental to their consumers. So also is the excessive use of other spices, such as black pepper, cardamom, cinnamon, cloves, etc., which, though they stimulate the motor functions of the stomach, impair the secretory function, and thus inhibit the production of hydrochloric acid. The inordinate use of chillies and spices, therefore, causes dyspepsia and disordered digestion in the people of this country.

The people of India, being for the most part vegetarians, require more common salt, that is, sodium chloride, than meat-eaters. In the tropics and in the hot season, a larger quantity of salt should be taken than in the temperate climates or cold season, for the activity of the skin eliminates from

*Regarding potatoes, the golden maxim to be observed is *Non-exposure to light.*

As cultivaters of the potato in India observe the maxim of *Non-exposure to light* more in its breach than otherwise, it is easy to understand how unwholesome that article becomes by the action of the tropical sun.

the body a large amount of salt by perspiration. But, unfortunately, they cannot afford to consume salt in sufficiently large quantities, because salt is very heavily taxed in India. No wonder that the general health of the people of India is not what it should be. Writes an American author :—

" Whenever a high tax has been imposed on salt and its use restricted, the health of the people has suffered."

(Dieto-Therapy by Fitch, Vol. I.' p. 256.)

In the same work (on p. 676. Vol. I.) it is also stated that—

" A lack of sodium salts eventually interferes with the excretion of purins, allowing them to accumulate in the blood and to cause irritations. Diminution of the sodium salts, we know, reduces the alkalinity of the blood to perhaps the point of acidity, in the excretions at least, and this interferes with the activity of the oxidases in their protective functions against invading organisms."

II. Disordered conditions of the digestive juices producing alimentary toxaemia.

It has been very truly observed by Professor Emil Abderhalden that—

' The functions of the intestine and the digestive ferments are to be regarded in a quite particular

light. First of all, they guarantee collectively the correct course of the general metabolism. The digestive ferments act before the intestine does. They furnish the intestine with the building materials from which it forms homogeneous products for the cell-metabolism. It now becomes apparent why any derangement of the alimentary tract should have such a far-reaching effect upon all processes of metabolism. It is not the deranged absorption which is so important. It is the deranged assimilation. The intestine itself is one of the most important organs. Many important syntheses and changes are carried on within its walls............... Our present knowledge indicates that a synthesis of the albuminous cleavage of products takes place in the walls of the intestine." (P. 213 Abderhaldan's Physiological Chemistry).

In an interesting article on *Intestinal infections and toxæmias and their biological treatment*, in *the Medical World* of January 5, 1923, Drs. N. Philip Norman and Andrew A. Eggston write :—

" Many diseases have been attributed to the more evident infected areas of the upper digestive and respiratory tracts, unmindful of the extensive amount of hidden areas in the intestines equally

well suited and susceptible for the harbouring of pyogenic bacteria. We have designated these obscure infections as occult foci of infection.

" The teeth, tonsils and sinuses are more accessible to examination than are the gall bladder, pancreas, doudenum, appendix, colon and rectum. In spite of their accessibility, the teeth, tonsils and sinuses are often neglected. It is therefore obvious why the hidden structures suffer an even greater neglect...... The extensive amount of mucoid, lymphatic and glandular tissues of the intestinal tract, which is constantly exposed to infection, certainly merits a careful and searching consideration which hitherto, has not been universally accorded to the intestinal tract."

The digestive juices are disordered from many causes, such as worries, anxieties, excitements, nervous disturbances, irregularities in diet, unmasticated food, etc.

The nervous strain connected with modern life is a well-known cause of disordered digestion. India is a country where, from time immemorial, people were accustomed to take their principal meal in the middle of the day, after which they

used to spend an hour or so in *siesta*, which allowed for the proper digestion of food. But under the altered conditions of their existence, they do not find time even to properly chew and masticate their food, which they are obliged to bolt down as soon as they can, to attend to their studies or business in the middle of the day. By proper mastication of food, alimentary toxæmia is reduced to a minimum. In an account of some experiments initiated by Mr. Horace Fletcher, which Dr. Ernest Van Someren in 1901 submitted to the British Medical Association, and afterwards to the Congress of Physiologists at Turin, it is stated that—

"One fact, fully confirmed by the Cambridge observations, consists in the effect of the special habits described upon the waste products of the bowel. These are greatly reduced in amount, as might be expected; but they are also markedly changed in character, becoming odourless and inoffensive, and assuming a condition which suggests that the intestine is in a healthier and more aseptic condition than is the case under ordinary circumstances."

Everyone should be taught to properly masticate

and insalivate the food—it is one of the most necessary conditions of good health.*

Worries and anxieties are important factors in the causation of toxæmia, and hence of diabetes.

III. The most important factor in the production of alimentary toxæmia is the **discharge of toxins by the bacteria in the alimentary canal.** Constipation from any cause and intestinal stasis —by not allowing free evacuation of the contents of the intestines – bring about toxæmia.

One of the most important causes of alimentary toxæmia in India is undoubtedly the condition of the latrines generally all over the country. The civilization of a land is to be judged from the condition of its latrines. In rural tracts, no latrines are attached to dwelling-houses, as their inhabitants go to the fields for purposes of nature. This has its obvious advantages. But in towns the latrines generally are not what they should be.

* The ferment of saliva, known as ptyalin, is slow in its action. Hence it is necessary to properly masticate the food and keep it for some time in the mouth to mix it intimately with the ferment. For the proper action of saliva on food it is also necessary that the latter should be well diluted. This is effected by the drinking of water with meals which brings about a greater action of the ferment.

They are ill-ventilated, filthy, and not sufficient in number to meet the requirements of the members of a large household. As a rule, it is disgusting to many to visit them to answer the urgent and important call of nature, and people should be advised to improve them as soon as possible.

Man is the only quadruped mammal who has attained erect posture in course of evolution. But his alimentary canal has not adjusted or adapted itself to his erect posture. Hence there is disharmony; and he suffers more from the effects of alimentary toxæmia than any other quadruped mammal. The Indian mode of crouching posture at defæcation empties the bowels more completely than the European method of sitting at commode for answering the call of nature. As a good many educated Indians are imitating the European method, in this respect, as well as in the use of tinned and preserved foods, they are suffering from the evil consequences of alimentary toxæmia of which Diabetes Mellitus is one.

Various, then, are the causes which give rise to alimentary toxæmia. Oral sepsis, piles, errors in diet, malaria, worries, anxieties, etc., are principally responsible for the occurrence of alimentary

toxæmia amongst educated Indians.

Adulteration of food-stuffs in large towns, the difficulty of procuring good *ghee* and milk which enter largely into Indian dietary, polished rice, exportation of wheat and, consequently, the subsistance of a large population on inferior food-grains, the restricted use of common salt as a result of the high tax imposed on it, are mainly the different factors in the causation of Indian diseases and especially of alimentary toxæmia.

Blood pressure and Diabetes.—It has been mentioned above in the pre-glycosuric stage, there is often high blood pressure. In former times, blood-letting was practised at least once a year, which did not raise the blood pressure. But blood-letting is a good old remedy now out of fashion. The researches of Dr. W. E. Dixon show that the urine of meat-eaters generally contains a large amount of a body which, when injected into animals, very markedly raises their blood pressure. After 40 years of age, when changes of a degenerative character take place in the arteries, all meat and animal proteins should be avoided. Thus meat-eating, by raising the blood pressure, is one of the causes of diabetes.

The wide prevalence of malaria *in different provinces of India also explains the occurrence of alimentary toxæmia. Malarial patients suffer from enlarged spleen, which seriously interferes with pancreatic digestion. There are many who associate diabetes with the organic or functional disorder of the pancreas. If that be so, the enlargement of the spleen accounts for the occurrence of the pancreatic disturbance. According to Herzen, the spleen furnishes an internal secretion which causes in the pancreas the transformation of its inert trypsinogen into trypsin.

The influence of the nervous system in the production of alimentary toxæmia is so well-known that it needs only a passing allusion.

Again, if pathological changes of the pancreas be the real etiological factor in the production of diabetes, we know that pancreatitis is very often set up by oral sepsis.

By not assigning due importance to alimentary toxæmia as causing diabetes it has been attributed

*Malaria, unless it gives rise to alimentary toxæmia, does not often lead to glycosuria. This explains why the West Coast of Africa and British Guiana, which are malarious, are not diabetic.

to several causes. It has been said that amongst Indians it is chiefly due to sexual excesses. As a rule, they, and especially the educated portion amongst them, are not given to so much sexual excesses as inhabitants of the Western countries*. It is the educated Indians who suffer more than their uneducated countrymen from this disease. It passes one's comprehension why they should be more vicious than their uneducated brethren, as far as sexual morality goes.

Then, again, it has been said that Indians, being very fond of saccharine food-stuffs, fall easy victims to diabetes. Consumption of a large quantity of carbo-hydrates and of sweets, no doubt very often produces glycosuria and alimentary toxæmia, resulting in diabetes. But when we remember that Hindu priests generally, and the Chaubeys of Muttra especially, as well as the labourers employed in sugar factories in Mauritius and British Guiana, indulge largely in sweetmeats without suffering from diabetes, we should not be justified in

*See the chapter on "Morality of the natives of England" in *My Sojourn in England*, by Major B. D. Basu, I. M. S. (Retired).

considering the disease as resulting from an excessive indulgence in sweet stuffs alone.*

Is Sugar a Poison ?

The question, however arises, whether the sugar present in the blood of diabetics acts as a poison on the system and accounts for the complications and other symptoms of the disease. Is sugar in itself a poison ? No evidence of this exists. It is not known to act deleteriously on animal or vegetable tissues. From the fact that it is used as a preservative of foods, its importance as an useful substance in domestic economy, can be well judged.

That in animal economy also it is useful to destroy toxicity of intestinal flora, is to be inferred from Metchnikoff's experiments introducing bacilli in the intestines to produce sugar.

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* 'Excess of starchy food alone cannot cause glycosuria in healthy persons. This view receives additional confirmation from the fact that there is little diabetes among Japanese whose food is largely of a starchy nature" *Chem. Abstr.*, Oct. 10, 1916, p. 2480).

My view as to Diabetes Mellitus being due to toxæmia is now shared by some medical men of the West also. See the article on " The Toxic Factor in Disease, with special reference to Chronic rheumatic conditions and Diabetes " in the *Practitioner* for May 1925, by Sir William. Willcox, KC. I. E. M. D., F.R.C.P.

If we introduce sugar into the blood of healthy animals by injection or infusion for any length of time, the symptoms and complications of diabetes will not be set up.

If sugar is not a poison, what is its significance in diabetes as opposed to simple glycosuria ? Nature always tries to set wrong right. Hence the proverb that every disease creates its own remedy. May it not be that sugar is produced in the system to get rid of the deleterious effects ef alimentary toxæmia and to serve the purpose of an antidote ?

It is not yet fully known what is the function of sugar in the blood of which it is a normal constituent. But we know that it is an energy producer and an agent to increase the oxidation in the body.

In diabetes there is defective oxidation. Hence the effort of Nature to increase it by greater production of sugar.

There are many practitioners who look upon high temperatures in fevers as necessary to kill the germs of those diseases. So perhaps may be the sugar in diabetes.

Sugar—a local irritant.

But if sugar is not a poison, it acts as a local irritant, which accounts for some of the cutaneous and other troubles, such as Herpes preputialis, cystitis, etc., often observed in the course of diabetes.

Pathological antagonism in relation to Diabetes Mellitus.

Medical practitioners in India must have noticed the clinical fact that diabetic patients do not excrete sugar in their urine when they suffer from Bright's Disease, Pneumonia, Tuberculosis, and fevers generally. The occurrence of glycosuria cannot be explained as simply due to structural changes in the pancreas, nervous system, liver or any other organ. But if we look upon diabetes as a manifestation of alimentary toxæmia, then we are in a position to account for the disappearance of sugar in such diseases as mentioned above which might supervene on diabetes. The toxin, which requires the formation of sugar in the system for its neutralization, is got rid of in the course of those diseases, and hence sugar is no longer required to prevent its deleterious effects.

It is, therefore, that I look upon diabetes as a functional disorder and hence curable.

Diabetic Coma.

Very often, the closing scene of Diabetes is coma. It is due to toxic substances acting on the kidneys. In evidence of this may be adduced the fact that the urine contains renal casts long before the occurance of coma. The blood also wants alkalinity ; hence, the administration of alkalis, for example, of bicarbonate of soda in large doses, has been found beneficial in diabetic coma.

It is here necessary to say that Sodium Bicarbonate should not be given indiscriminately in all cases of diabetes. Some of its evil effects are pointed out later on. Moreover, the habitual use of Sodium Bicarbonate, by lessening the acidity of the gastric juice, tends to favour putrefactive processes in the intestines by producing flatulence and fermentation in them.

In diabetes, œdema occurs when there is a pronounced acidosis. The œdema disappears if Potassium chloride is substituted for Sodium chloride (common salt.)

Acidosis, as a grave complication of Diabetes, is not so common in India as in cold countries, Perhaps this may be explained, to a certain extent, by the fact that excretory function of the skin is not so much suppressed in India as elsewhere. According to Mr. R. J Rinnitt, of Liverpool, who has observed the occurrence of acidosis in persons suffering from burns and scalds (B. M. J., 3rd Feb., 1917, p. 155), the cause may be due "possibly, to some extent, to the suppression of the excretory function of the skin."

The following, are some of the causes of acidosis, *viz* :—

1. Constipation.
2. Skin not acting properly.
3. Large intake of proteins.
4. Large intake of fats.
5. Retention in blood of the non-protein and urea nitrogen and of the chloride.
6. Starvation.
7. Surgical shock.
8. Anæsthesia.
9. Suspended circulation (Lancet **1918. P. 763-5**).

The role of catalese in acidosis :—

In defective and decreased oxidation due to decrease in catalese an enzyme found in the tissues and possessing the property of liberating oxygen from water. In diabetes the catalese content of the heart decreased by about 48% and that of the liver by about 72%.

Coma mostly occurs in those who are made to take opium and flesh-foods in the hope of being cured of the disease. As results of that drug and diet, the kidneys are disorganized, the proper elimination of toxins is interfered with and the blood is made lacking in alkalinity. Hence, opium and flesh-foods should not be given to diabetics.

Ocular complications of Diabetes.

In the Calcutta Medical Journal, February, 1926, Dr. S. K. MUKHERJEE, F.R.C.S. (EDIN.), D.O. (OXON.) D.O M.S. (LOND.) writes :—

"Diabetes is a disease in which ocular complications are frequent and important and occur in various forms. They can be classified as follows :—

(I) Common.
(II) Less common.
(III) Rare.

"The material upon which I am writing this paper consists of clinical notes of about 60 cases whom I have examined from time to time, in some cases for a period of 4 to 5 years. I shall consider these different manifestations individually *in short* as this paper will form a part of the Special Diabetes Issue of our Calcutta Medical Journal. I intend to deal elaborately with this subject in a later issue.

"The Commoner Complications are :

(i) Changes in the power of Accommodation.
(ii) Changes in Refractive Error.
(iii) Retinitis.

"Less Common :

(i) Iritis.
(ii) Cataract.
(iii) Retrobulbar Neuritis.

"Rare :

(i) Ophthalmoplegia.
(ii) Lipemia Retinalis.
(iii) Retinal and vitreous Hemorrhage.
(iv) Relapsing Scleritis."

Treatment of Diabetes.

Almost every important drug of our Materia

Medica has been credited sometime or other with being a cure for diabetes. That such drugs might have proved beneficial in some instances, may be easily understood, if we consider diabetes as a manifestation of alimentary toxæmia. Anything which relieves the latter, will prove beneficial in diabetes. This view alone can satisfactorily account for the large number of medicines said to have been successfully used in its treatment. Every individual case should be treated on its own merits, and attempts should be made to discover the cause or causes of glycosuria.

Spring waters, containing sulphur, probably in a colloidol condition and in a form not otherwise available in medicine, by their action upon alimentary toxæmia, are beneficial in Diabetes. In India, there are several springs containing sulphuretted waters, such as of Guhya Pani, near Dehra Dun, Dhara Tirth, near Laki, in Sindh, which are useful in Diabetes.*

*Dr. R. Fortesque Fox concluded his lecture on 'British Resorts in Peace and War' (published in the *B. M. J.* for July 17, 1915) as follows :—

"India alone is richly endowed with medicinal waters of every description. No scientific report has ever,

I have always laid stress on the exclusion of meat from the dietary of the diabetic and the substitution of the vegetarian diet, in the treatment of this disorder. It is very gratifying to me to find that such has been the experience of many medical men in the West also. Because vegetarian diet is better calculated to relieve alimentary toxæmia, therefore, it should be the dietary of the diabetic.

Constipation.

Diabetics complain of constipation. The question of a suitable purgative to relieve this condition has been considered by many physicians. In former times, some advocated Castor Oil while others Magnesium Sulphate. But the habitual use of either of these purgatives does harm to the system. Latterly the use of the Liquid Paraffin has been recommended.

The ingestion of saline mineral waters, such as Apenta, in the morning has been found useful to

admittedly, been made upon them. There and elsewhere much remains to be done to investigate, make known and utilize the natural resources of the empire."

See my paper on "Indian Mineral Waters" in *The Modern Review* for October, 1921.

relieve constipation. In India it is not necessary to depend on the imported foreign mineral waters. Constipation of the diabetic is relieved by the use of *Black Salt*, called in Hindi, *Kala Nimak*; in Bengali, *Bit Laban*, *10 to 30 grains in the morning, followed by a copious draught of tepid water. This has been found by me very beneficial in constipation of the diabetic.

The use of Black Salt is recommended in diabetes because it relieves constipation, keeps the blood alkaline and thus prevents acidosis and improves digestion. It can be given with more impunity to diabetics than Sodium Bicarbonate, for the evil effects consequent on the administration of Sodium salts are more or less neutralized by its combination with the two myroboluns.

*In the *Dictionary of the Economic Products of India*, it is stated that "Black Salt is prepared in Upper India chiefly at Bhiwani in the Hissar district by heating together in a large earthen pot 82 ℔ of common salt, one pound of the fruit of *Terminalia Chebula*, one pound of *Phyllanthus Emblica*, and one pound of *Sajji*, impure carbonate of Soda, until by fusion of the salt the ingredients are well mixed, when the pot is removed from the fire and its contents allowed to cool and form a hard cellular mass. This preparation is used medicinally principally as a digestive." (Vol. VI. part II, p. 415.)

Fasting.

It is noticed that diabetic patients improve by fasting. Of late, some physicians have been treating diseases by fasting. This fasting cure, of course, relieves alimentary toxæmia, and so proves beneficial in diabetes. Hence, the importance of starvation and purgation in diabetes. There should be no over-indulgence in food.

Physical Exercise for Diabetics.

Diabetics are benefited by physical exercise. This is also accounted for by the disease being considered a manifestation of alimentary toxæmia.

It has been noted that obese persons often suffer from diabetes. The accumulation of fat around the intestines, liver and the kidneys prevents their free movements, and thus removal of poisonous products, the re-absorption of which causes toxæmia. Hence the necessity of physical exercise in the treatment of diabetes.

But exercise is harmful in severe cases of Diabetes.

In vigorous exercise there is rapid accumulation of lactic acid in the circulating blood and so there is danger of acidosis.

The Care of the Skin in Diabetes.

The skin should not be deprived of its full breathing opportunities and prevented from throwing off the poisons which come to its surface. In India, in certain seasons of the year, a bare skin is more conducive to health than with clothes on.

Baths are very useful in the treatment of Diabetes. Some precautions are, however, necessary to be taken in their administration. Hot baths, on account of the debilitating effects of heat, should be avoided, as far as possible. Turkish baths should not be recommended for diabetics. These are harmful, because of their excessive scrubbing and soaping of the skin which removes certain of its protective elements.

Precautions should be taken against what is called "Bather's Cramp." It is very often caused by the shock of cold applied to the surface of the unduly heated body.

It was a custom with the Romans to rub their bodies with oil both before their bath and after. This practice was called the "alliaptic art.' The Bengalis resemble them in this respect to the ex-

tent that they use it only *before* the bath. The Oriyas and the Telegus also occasionally use oil like the Bengalis. Taking oil baths and rubbing the body with oil are very beneficial in diabetes, inasmuch as they remove the dryness and harshness of the skin and render it immune to the attack of various affections and bites of insects. Moreover, the rubbing, serving the purpose of massage, relieves alimentary toxæmia. Constipation is a very troublesome symptom of diabetes. It is well-known that, after steady abdominal friction, the action of the bowels often follows. It should also be remembered that by inunctions of fatty substances, fats are introduced and absorbed into the system, and hence do good in diabetes.

On the other hand, soap should not be largely used The pores of the skin are filled by the excessive use of soap, preventing the sweat glands from performing their normal function and thus causing respiratory diseases.

Light Bath in Diabetes.

In the *Scientific American* for April 17, 1915 (p. 255), there is an important paper on "The uses

of Light in the treatment of Disease," by Mr. E. C. Titus. He writes :—

"It must be remembered that the thermic effects of light are due to the impingement of the rays upon the translucent cutaneous tissues. The arrest of the light rays by the skin and subcutaneous structures produce radiant heat which has a higher penetrating power than convection heat as generated by a hot-water bag or paultice, for instance. It has been found that the thermic effects of light extend to a depth of two inches or more, while convection heat is principally exerted upon the surface ....Thus, if the body be exposed to an intense light, as in an electric light cabinet bath, the resulting hyperæmia and elimination of waste praducts by the skin and kidneys (cellular nutrition) are much more pronounced than in a Turkish or Russian bath.........

"The light baths are not adapted to every case of Diabetes, but particularly to patients who present a dry skin with various cutaneous eruptions, especially of an eczematous character. The best results are obtained where diabetes is attended with high blood pressure."

Gastric lavage and douche.

The cases of diabetes reported to have been benefited or cured by gastric lavage and rectal douches can only be explained on the theory of their being due to alimentary toxæmia.

Since Metchnikoff pointed out the part which intestinal flora play in the production of alimentary toxæmia, the alimentary canal has been mercilessly subjected to the knife of the surgeon. But the surgeon's knife is not necessary to relieve the disorder.

Importance of Yoga.

The holy sages of India found out for themselves the curability of alimentary toxæmia by means which we may adopt even now with great advantage. They evolved the system of yoga, the practitioners of which were said not only to attain longevity, but immortality. My brother, the late lamented Rai Bahadur Srish Chandra Vidyarnava, kindled the interest of the public in the study of this system of Hindu philosopy by his writings on the subject. From the Introduction to his translation of the *Gheranda Samhita*, written in 1893, the extracts given below will show the

importance of relieving alimentary toxæmia by methods practised by the votaries of *yoga* :—

"Although it is not possible, within the short space at my command, to give the rationale of *all* these practices and to justify them to a doubting public, I shall briefly illustrate the advantages of some of them. Thus, to begin with Vatasara, it is the process of filling the stomach with air, and expelling the wind through the posterior passage. The greatest duct or canal in the human body is the alimentary canal, beginning with the œsophagus (throat) and ending with the rectum. It is some twenty-six feet in length. This great drain contains all the rubbish of the body. Nature periodically cleanses it. *Yoga* practice makes that cleansing thorough and voluntary. If the cleansing is incomplete, then the fœtid matters putrify in the stomach and intestines, and generate noxious and deleterious gases which cause diseases. Now वातसार (Vatasara), by passing a current of air through the canal, causes the oxidation of the fœtid products of the body ; and thus conduces to health and increases digestion. In fact, it gives a tone to the whole system. Simlarly, वारिसार (Varisara) is flushing the canal with water, instead

of air. It thoroughly purges the whole canal, and does the same work as an aperient or a purgative, but with ten times more efficacy and without the injurious effects of these drugs."

The *Gheranda Samhita* describes the internal washing under the term *Antardhauti*, as follows :—

"Antardhauti is again sub-divided into four parts :—Vatasara (wind purification), Varisara (water purification), Vahnisara (fire purification), and Bahiskrita."

The sages of India thoroughly understood the danger of alimentary toxæmia and devised means to efficiently combat the evil results of the same.

To attain to the stage of *samadhi* or suspended animation the body should be cleansed of all its impurities. The different processes described in works on *yoga*, aim at this end. Thus the various *asanas* or postures, mentioned in treatises on *yoga*, are calculated to prevent chronic intestinal stasis, by the occurrence of ptosis. The abdominal organs depend mainly for the maintenance of their position on the support of the abdominal muscles. The *asanas* develop the abdominal muscles, and thus reduce the possibility of the occurrence of ptosis to a minimum.

INSULIN THERAPY.

(Contributed by Dr. L. M. Basu, M. B.)

As the outstanding characteristic of diabetes, irrespective of all theories of its causation, is decreased capacity for utilization of carbohydrates, some of the chief facts of carbohydrate metabolism may be briefly presented, preliminary to a discussion of Insulin therapy [1].

Carbohydrate Metabolism in Health :—

Under ordinary circumstances the greater part of our food consists of carbohydrate material taken in the form of starch. Whatever the nature of the starch may be, it is very quickly broken down in the gastrointestinal tract and changed into glucose. As glucose it is absorbed into the circulation, to be finally oxidised and excreted in the form of carbon dioxide and water. In healthy individuals quite enormous amount of starch can be ingested without any sugar being excreted in the urine

It is a curious fact that no matter how much carbohydrate is taken, the amount of sugar in the general circulation is not increased except quite

temporarily. Since sugar is utilised in the body and rapidly disappears as such from the tissues very soon after being taken, it is obvious that sugar must either be quickly converted into some other substance or that it must be equally rapidly destroyed as the result of the normal processes of oxidation [2].

So far is the fate which the carbohydrate meets with when taken by the mouth. So it is usually classified as 'exogenous', *i.e.* derived from outside source but a fairly large amount of sugar is derived from the body protein and fat, and it has been estimated to yield, in a starving diabetic of average body weight from 50 to 100 Gms. per day [1].

In whatever form the carbohydrate might enter the system it first goes to the liver, which is the principal store-house of sugar, and thence to the muscles to be finally oxidised. The sugar, it is said, is stored in the liver and muscles in almost equal proportions in each and the form in which it is stored is called glycogen which is the product which is finally utilised to produce energy. The transport of this sugar (*i. e.* glycogen) from one

place to the other takes place through the blood. But the sugar in the blood, during this transport, is not the same as it is stored in the liver or muscles, but is changed into some other form. This metamorphosis of sugar from their temporary store-houses takes place by the actions of certain enzymes which are again different for the different forms of changes.

Play of endocrine glands in the regulation of sugar in the body :—

As said above blood carries the sugar from one place to the other and this mobilisation is well regulated by the combined actions of several factors. Normally, there are some organisms in the body which initiate the store houses, principally the liver, to discharge sugar into the circulation and there are others again which control their actions so that the former might not be over energetic and do their work overmuch and get fatigued and useless at the time of need. As all other active processes in the body receive the command to work, in the field of action, from the brain or the Central Nervous System, so too is the case with the order of "march" for the sugar. There is a

place solely made for the sugar metabolism in the Central Nervous System which sends the impetus for the sugar to 'go'. But this 'go' order does not pass to the liver direct but passes through relays and the first relay is the sympathetic nervous system or the vegetative nervous system. So, in other words, the Central Nervous System excites the Sympathetic Nervous System to work which again through the splanchnic sympathetic sends message to the liver to produce sugar. What happens is, the excitability of the splanchnic sympathetic induces vaso-constriction of the capillaries in the liver, entails hypotension of the interstitial plasma, with aspiration of glycogen from the interior and discharge into the circulation, the intensity of function depending on the intensity of the blood supply, other things being equal.

So liver goes on pouring in sugar constantly. But there again the sugar which has thus come out of the belly of liver and begins to peep into the blood is not tolerated by the zealous Pancreas, which comes and burns it off. Had this 'sugar intolerant' wrath of pancreas being left uncon-

trolled all of us would have been born diabetics, but nay, there is the control over this destructive action of pancreas and it is governed by two other organs in the body, the Thyroid and the Adrenals, they inhibit the pancreas and inter-stimulate amongst themselves. Thyroid in this connection, rides as it were on two powerful horses Pancreas and Adrenals, with two pairs of reins. When it gets excited it tightens the pancreatic rein hence inhibits its action and lets loose the other pair and so excites the adrenels. Adrenals on the other hand excites sympathetic system and hence gives rise to the production of sugar. So when thyroid is excited there is hyperglycosuria, that is, sugar tolerance is lowered, and when the adrenals are excited there is also hyperglycosuria ; but when their function is lowered the sugar tolerance is raised[1].

Pancreas and its manifold function :—

In no other of the many causes of diabetes has greater interest been shown than in that due to disturbance in the pancreatic function[4], and so to govern this pancreatic action is the most difficult

question in the metabolism in Diabetes Mellitus and a constant watch over it is necessary in order to maintain health. The functions of the Pancreas are manifold. It secretes an external secretion which is discharged in the duodenum through Wirsung's duct containing very powerful ferments for protein, fat and carbohydrate and some go so far as to state that these ferments are responsible for the major portion of the chemical digestive changes of food, the changes taking place in the mouth and stomach being relatively insignificant. It gives out an internal secretion, called Insulin produced from the Islands of Langerhans. The precise part played by insulin is uncertain, but most researches have ended with ascertaining certain effects resulting from its absence rather than determining the definite part taken by it, in carbohydrate metabolism[5].

Where Insulin acts :—

As said above it is not yet decided excatly where and how does the Insulin act, but it has been observed that it alters or destroys the sugar that is present in the blood in conjunction with

a substance always or usually present in the muscles[6].

Blood Sugar :—

Sugar is transported from its store-houses to meet the body's need through the agency of blood. It has been seen that the sugar that is present in the blood is not the same in constitution to that present in the liver or muscles where they generally lie.

As to the precise nature of sugar that exists in the blood, there has been much dispute. We now know that there is a series of different varieties of glucose molecule, *e.g.*, alph-glucose, beta-glucose and gamma-glucose. It is believed by many that glucose in the form that exists in the blood cannot be utilized for oxidation by the tissues until it has undergone a stereochemical transformation, which permits of enzymetic splitting in the tissue cells precedent to oxidation. And it is believed by some that insulin is the substance that is responsible for this stereochemical transformation of "transport-glucose" into a glucose that can be split and oxidised[7]. This blood sugar, as it is called, varies by intake of diet and in health and disease.

Blood sugar in the normal and diabeties[8] :—

Uptil 1911, it was believed that blood sugar remained at a constant level inspite of large intake of carbohydrate diet. Pavy said that liver prevented any rise in blood sugar and if by any chance liver was deranged, hyperglycaemia resulted which excess of sugar was immediately excreted in the urine.

Curves in health :—

Speaking generally in healthy adults the highest blood-sugar reading should occur within an hour of taking the sugar. Immediately after the maximum figure is reached the blood sugar begins to fall, and this fall is almost as rapid as the initial rise, so that in healthy young subject the blood sugar is usually little above the fasting level some 90 minutes after the ingestion of the sugar. Frequently, indeed, it is even below the original level at this time. In some subjects following this stage of fall of curve there is a slight secondary rise before the blood sugar settles down to its normal fasting level. The maximum blood sugar concentration on a good average,

in the healthy adults, being 0·17 to 0·18 per cent.

Curves in diabetes :—

Starting from the raised fasting level of 0·17 per cent the blood sugar rises steadily, until after 45 minutes, it has attained the high maximum of 0·29 per cent. The highest blood sugar reading at the period of maximum rise on an average being 0·29 per cent., but the actual height to which the curve rises depends not only on the severity of the disease and the quantity of sugar ingested but also on the height from which the curve starts and whether this fasting level has been reduced or not by treatment. Following the attainment of the point of highest rise the blood sugar concentration begins to fall, but the decline is slow and gradual, so that even after three hours it has not fallen to its original level.

Comparison of Diabetic and Normal curves :—

So the blood sugar curve in health shows a rapid rise, an almost equally rapid fall, the maximum concentration does not exceed the renal threshold, and sugar does not appear in the urine ; in diabetes, on the other hand, the rise is

rapid but much more prolonged, the fall is gradual and long drawn-out, the renal threshold is exceeded, and sugar appears in the urine.

Renal Threshold :—

By the threshold for the kidney for the sugar is meant the percentage level of sugar in the blood above which an amount of sugar recognisable by clinical tests appears iu the urine.

Explanation of certain features of this blood sugar concentration phenomenon :—

(*a*) Rapid rise in blood sugar concentration means rapid absorption of sugar into the blood which exceeds to that of storage.

(*b*) Abrupt fall means either,

(i) The sugar being excreted by the kidneys,

Or,

(ii) a sudden rise in the carbohydrate katabolism.

Or,

(iii) the sugar being removed from the blood and stored more quickly than it is absorbed.

(i) It is not possible that the sugar is always excreted by the kidneys for all urine specimens are sugar free.

(ii) No doubt some of the sugar is burnt in the body at once for both heat production and the respiratory quotient rise immediately after a carbohydrate meal, but experiments have been done by keeping the patients lying absolutely quite and feeding enough glucose and noting the rise in Carbon Dioxide output which lasts as long as six hours before falling to the fasting basis.

(iii) Therefore, some of the sugar must have been stored in the body ; the rapid fall in the normal blood sugar curve which occurs so soon after the maximum has been attained must be assumed, therefore, to be due to the sudden intervention of a storage mechanism, the activity of which is so great that the latter stages of absorption is marked by it. In the diabetic patient on the other hand this mechanism is absent or deficient. The diabetic curve, therefore. is a true picture of the rate of absorption than is the normal, though the result is complicated by a loss of sugar

in the urine and by a certain amount of sugar katabolism.

History of the Discovery of Insulin : its mode of preparation :—

Sir Edward Sharpe Schafer had suggested the name of Insulin to be given to the internal secretion of pancreas which mobilizes and utilizes the sugar in the blood and Scott in 1911 had experimentally tried to extract this internal secretion of pancreas. But in1922 the first step in this direction was taken by Banting of the University of Toronto assisted by Best, who showed that the hormone could be extracted from the pancreas after the cells which produce the strong digestive enzymes had been caused to degenrate by previous ligation of the ducts. The next step was to seek for some extractive for the intact gland, in which the digestive enzymes would be incapable of attacking the hormone, and acid alcohol was found to fulfil these conditions. And the final step, due mainly to the work of J. B. Collip, was to purify the alcoholic extracts sufficiently so that they could be given subcutaneously or intravenously, to man without causing local irritation or general toxic reactions.

But Insulin that is made commercially is obtained chiefly from the pancreas of the sheep or pig, and is sold as watery solution of a more or less standard potency. [10]

The Standardization of Insulin :—

The establishment of some accurate standard of potency is the first obvious necessity whenever a new remedy of unknown chemical composition is introduced into medicine. [11]

The Toronto University people defined their unit as that amount which lowers the percentage of sugar in the blood of a normal rabit, weighing 2, Kg. and starved for 24 hours to ·045 per cent within three hours. [12]

But the Health Organization of the League of Nations carried on the Standardization of Insulin in the British National Institute of the Medical Research Council and came to the conclusion to form a unit which they like to call the clinical unit and this clinical unit is one-third of the above Toronto unit. [11]

Physiological Actions of Insulin :—

The oxidation of our food stuffs requires the presence of a substance which is normally supplied

by the pancreas. When, for some reason, the specialized pancreatic islet cells fail to supply this substance in the necessary amount, an interference with the burning up of sugar and fat results. This is the basis of Diabetes Mellitus.

The pancreas has the power, by means of the secretion which pours into the intestine by the pancreatic duct, of dealing with the digestion of carbohydrates, protiens and fats. This secretion is not at fault in diabetes. The carbohydrates when taken by the mouth appear in the blood as glucose. Some of the glucose remain in the blood, in some stereochemical form called alpha, beta, and gamma-glucose rendered such by the internal secretion of the intact pancreas, giving the blood a concentration of ·1 to 0·18 per cent of glucose. The rest is stored as glycogen in the liver, muscles, and other parts. The combustion of sugar takes place in greater part in muscles to form energy, and the glycogen storage depots are called on to supply their needs. During combustion glucose is broken up and excreted as water and carbon dioxide. What is not required may be deposited as fat. The normal kidneys are

impervious to sugar in the blood which is in a concentration less than 0·18 per cent. If for any reason sugar in the blood rises above that figure sugar appears in the urine.

Fats when consumed in the body are also broken down into water and carbon dioxide, but this takes place completely if some carbohydrate is being consumed at the same time or in other words fats burn in the fire of carbohydrates. If no carbohydrate or insufficient carbohydrate is being consumed, then combustion of fat is not complete, and certain products of fatty acids called ketones or acetones, are formed which circulate in the blood and pass into the urine resulting in the formation of a state called ketosis, or acidosis, and the urine gives a reaction peculiar to acetones.

Proteins in their metabolism yield carbohydrates and as much as 58 per cent. So when the internal secretions of pancreas get defective the tissue proteins are called on to produce the carbohydrates and this they do. The result is that the blood is over charged with sugar firstly from the inactive glucose absorbed from the intestine

and secondly from that broken down from tissue protiens. All these sugars cause the blood sugar to rise much higher than that its normal level of 0·18 per cent and the result is that the excess of sugar passes into the urine.

Turning our attention to the state in which the functions of the pancreas is at fault we see that if we administer insulin to such a subject the sugars in the blood are metamorphosed into a state in which they are easily broken down into their end products and also stored in the liver, the fats are completely burnt with the result that the acetone bodies disappear completely from the blood and indirectly from the urine; proteins are saved and hence there is no excess of sugar in the blood nor does any leak out into the urine and so the subject gains in health and feels much better.

Therefore, the immediate physiological action of insulin on diabetes is firstly, a control over gluco-regulation disturbance; secondly, over disturbed nitrogenous metabolism; and, thirdly, over disturbances of the metabolism of fats and lipoids.[14]

fourthly, betterment of general condition by patient.

When Insulin is injected to a normal Rabit a train of symptoms follows due to the lowering of the blood sugar. So when it falls below, ·1 per cent, the subject feels tremulous, tired and nervous and so on, ·this senstation is·called hyper-glycaemic sypmptom, which we shall have to deal later on.

The death of a diabetic patient is due to some preventable complication of diabetes or to an intercurrent disease[16].

Insulin is not a cure for diabetes, neither it is a cure for the lesion of the pancreas any more than digitalis is a cure for the myocardial degenaration.

All cases of glycosuria are not cases of diabetes mellitus. Before turning our attention to the insulin treatment of diabetes we must first of all determine whether the case is one of true diabetes.

From the stand point of Insulin therapy the diabetics have been classified into three forms, the serious, mild and intermediate forms.

Serious cases are those where there is the disturbance of co trol over glucoregulation ; the nitrogenous metabolism is disturbed ; and there is the over disturbance of the metabolism of fats and lipoids. In these cases insulin is urgently needed and with its exhibition the glycosuria decreases and finally disappears, the reserve of glycogen in the liver is restored, while glycaemia lessens and approaches the normal.

In mild diabetes, where only a disturbance in the carbohydrate metabolism exists, with no nitrogenous denutrition nor acidosis, and where the carbohydrate utilization is still high, the use of insulin is not indicated. By diet alone the hyperglycæmia and glycosuria are easily controlled ; by starving one can in twenty-four hours stop a glycosuria of several hundred grams. In these circumstances, insulin does little to increase the carbohydrate tolerance ; considerable amounts would have to be injected if suppression of glycosuria were to be obtained without at the same time reducing the intake of carbohydrates of the diet.

In the intermidiary forms of diabetes, between the serious and mild types, in diabetes of the young

subjects which invariably progressively evolve towards acidosis and aggravation, insulin renders great service. Some of these patients have a very small tolerance, so that an extremely severe diet, difficult to support, must be given to obtain suppression of the glycosuria, and even then it will reappear with the very slightest digression in diet, while the glycaemia can never be made to drop to normal. The continuation of strict, reduced diet, the state of nitrogenous denutrition which is set up, bring about emaciation and progressive loss of strength ; the patient feels fatigued, weak, and suffer from general bodily distress. At last, little attacks of acidosis arise following an infection or digression of diet, and even after repeated diet cures the complete disappearance of acidosis does not ensue, but rather becomes set up in a moderate degree. In these circumstances, insulin works wonders. It causes the acidosis to disappear, re-establishes the nitrogenous equilibrium, increases the body weight and strength, facilitates the disappearance of glucosuria, while at the same time, with a reconstituting diet, it lowers the glycaemia to the normal level'[4].

The distinction of these types of cases are made on the principle of basal maintainance diet or the minimum diet adequate for the individual under treatment. So at the beginning of treatment all cases of diabetes mellitus, except those suffering from severe acidosis. and coma, should be put to bed and given this diet. This diet contains protein sufficient to replace the daily wear and tear of the tissues of the body, approximately 0.3 gm. per pound of body weight. Additional calories in the food are supplied by carbohydrates and fat in proper proportion to prevent the production of acetone bodies and in adequate amount from the height, weight and sex of the patient[12].

In practice Woodyatt's diet forms an excellent working basis ; it contains 50 grams of protein and has a total value of 1,679 calories. It is adequate for a person weighing 140lb. or 10st. Growing children need relatively more protein than adults. Carbohydrate in the proportion 1 gram of carbohydrate for every 1·5 gram of fat is required to enable the fat to be burnt up. If fat is in excess in the diet ketosis occurs. Woodyatt

has evolved a simple formula for regulating proportions in the diet :

Fat should equal the sum of twice the carbohydrate plus half protein ($F = 2C. + 0{\cdot}5P.$).

This formula takes into consideration a fact not always borne in mind—that protein contains a large amount of potential glucose. The total protein glucose in a diet equals all the carbohydrate plus half the protein and one-tenth of the fat ($G. = C. + 0.5P. + 0.1F.$).

Reckoning according to these formulæ, Woodyatt's basal requirement diet of 1,679 calories may be made up of ; fat 139 grams, carbohydrate 57 grams, protein 50 grams. Since each gram of fat yields 9 calories and each gram of carbohydrate and of protein 4 calories, in order to calculate the number of calories in this diet we proceed as follows :—

Fat................	139	9	1251
Carbohydrate...	57	4	228
Protein..........	50	4	200
		Total.......	1679.

These figures are easily remembered and from them any total number of calories can be reckoned

for a smaller or larger diet. In order to reduce or increase the diet we may subtract or add gram by gram from the fat, protein and carbohydrate until the necessary total of calories is reached. In ordering the weights we can convert grams to ounces by allowing 30 grams to 1 ounce.

The basal diet having been settled it is never reduced[16].

If the urine of the patient becomes free of sugar on this diet it should be gradually raised until he is receiving an adequate diet for the performance of ordinary duties of life. Should the patient remain aglycosuric on this diet, insulin treatment is not indicated.

If at the end of a week's treatment on a basal diet the urine is not free of sugar the patient requires insulin.

Indications for the use of Insulin :—

Chief danger of diabetics is infection plus an ill balanced diet. The infections again are general and local.

The general infections are :—

Pneumonia, often present and proves fatal.

Influenza, generally fatal when comes during epidemic or pandemic form.

Tuberculosis; diabetes may sometimes disappear when tuberculosis intervenes which is insidious in onset. Pyrexia is characteristically absent, hæmoptysis is rare, so that any loss of weight can be mistakenly attributed to diabetes. Suspicion of tuberculosis should be aroused whenever, an unexplained improvement of carbohydrate tolerance is seen in diabetics. Advent of insulin enables us to feed tuberculous patient with adequate diet. So that the diabetic consumptive is now no worse off than the non-diabetic in respect of nourishment.

Tonsillitis, Whooping-cough, Dysentry, Erysipelas, etc.

Local infections are generally more important than general :—

Septæcæmia, a common cause of death.

Boils, Carbuncles, Gangrenes—the form of gangrene seen in diabetics is not as a rule the sudden blockage of large blood vessels. When this occurs, as it does occassionally, the patient generaliy shows advanced arterio-sclerosis, and

the cause should be regarded as senile than diabetic gangrene. Such a patient may not survive amputation because of diabetes. But true diabetic gangrene is commonly caused by some local infection to which the soft tissues respond by a rapidly spreading necrosis. Comparitively slight injuries may lead to severe gangrene. Without surgical intervention may do no good; with insulin it may prove unnecessary; if insulin alone is not sufficient to check the progress of gangrene it will contribute wonderfully to the success of an amputation, or operation.

Gall stones, Cholecystitis, Pericholitis, Appendicitis, Dental abcess, Pyorrhœa, are precursers or exciting causes of diabetes and are chiefly dangerous by lowering the carbohydrate tolerance. With insulin to aid us operation can be undertaken with practically the same safety as in normal individuals.

Amongst the skin complications there are again two varieties, the non-infective and the infective ones, but this non-infective ones are directly dependant upon defective metabolism. The dry non-perspiring skin of diabetics requires

special consideration as it contributes largely to the pruritus, eczema, and faruncuulosis. Rosenfeld and Breslow in 1906 showed that by reducing the carbohydrate intake of healthy students the excretion of their skin fat could be brought to the same low level as that of a diabetic and in this condition the hair follicles are made excessibly susceptible to staphyloccoccal infection. The addition of fat to the diet did not increase the skin fat ; the addition of carbohydrate immediately caused it to rise to normal, and therewith the skin became more difficult to infect when cultures of staphylococcii were rubbed into it. Resort should be had to insulin specially when infection appears even though dieting without insulin has kept the diabetes sufficiently under control.

But all these infections more or less very soon lead to a condition called coma which requires very urgent and energetic treatment

Amongst the cases requiring surgical intervention there are the emergency ones which require immediate intervention, and the deliberate ones in which there is time to think and wait. In emergency cases 20 units of insulin should be at once

given if there is the history of diabetes or glycosuria. Renal glycosuria is less often met with. Keep glucose always ready. It is the carbohydrate that the post operative care of diabetics needs. So in the after treatment of operation give glucose, test blood sugar, fix carbohydrate diet and lessen gradually insulin. As regards the deliberate ones determine the blood sugar place the patient on adequate diet and insulin. During operation increase carbohydrate to over carbohydrate diet, for condition which is making the operation necessary, effect of operation as regards shock, anæsthetic etc.

Anæsthetics are fatal by producing the rise in blood sugar in an unknowu way. Chloroform is worst, Ether less so, Gas and oxygen safer, infiltration anæsthesia leads to sloughing and spinal anœsthesia brings coma soon.

There is a maxim which should be remembered during operations on diabetics and which is :—

Never starve a diabetic patient before operation. It is the sugar that protects diabetics and insulin only renders the blood sugar utilizable[16].

Dosage of Insulin :—

Cammidge says that if the beat results are to be obtained from the insulin treatment of diabetes,

the dose is a matter of great importance, for too little will not stay the progress of the disease, while too much may have disastrous consequences. Many factors enter into the administration of the optimum dose, and since they are never exactly the same in any two instances, each case is a law unto itself, but if the conditions existing are accurately ascertained for each patient it is possible to secure very satisfactory results with comparatively small doses, even in seemingly severe cases, and, further, a reduction is often possible, as influences interfering with the full physiologic effect of the insulin adminstered are eliminated or minimized by suitable diet and treatment[17].

A rough way to estimate the amount of Insulin to inject is to allow 0·3 to 0·5 unit of Insulin for each gram of sugar excreted in the urine. Or one may begin with ten units twice daily and gradually increase until the desired effect is produced[17].

Mode of administration of Insulin :—

Small doses of insulin frequently repeated are more effective than single large doses. The maximal result of each dose of insulin usually occurs at the end of four hours[18].

Insulin should be given hypodermically. Subcutaneous injection is better than intravenous for by the former method of application, a local depot is established and the insullin effect is not so soon exhausted as when the insulin is injected directly into the blood.

When two or more doses of insulin must be given over a considerable period, it is better to inject in turns first in the right thigh, then in the left thigh, then in the right arm, then in the left arm, then in the right buttock and finally in the left buttock. By such cycles one prevents the giving of too many injections in one locality, for if this be not avoided circumscribed atrophies of the subcutaneous fat will occur, due to local lypodystrophy that is caused by the insulin injections[7].

Reliable investigators agree that it is inert when given by mouth or rectum[19].

Time of administration of Insulin :—

The ideal administration would imitate the action of the normal pancreas in providing a continuous supply of insulin with increases at times of special need[19].

Insulin is usually administered just before meals. The object is to have the insulin act upon the

hyperglycaemia following each meal and also to prevent a hypoglycaemic reaction which might occur if the insulin administrations were not followed by food[19].

It should be given before a meal containing carbohydrate—Banting advises one hour before the meal—because carbohydrate in the food may stimulate the islet cells of the pancreas before the insulin has had time to exert its full effect[15].

The most convenient times for injections are before breakfast and before lunch

The theory that all food in excess of the patient's tolerance can be added to a single meal, seems fallacious, because only a small part of the food is actually utilized during digestion. The greater part is stored and the burden of its utilization then falls upon the pancreas at a time when there is no support from insulin. What happens with single dose is probably that the pancreas has complete rest for a few hours and must carry the load unaided through the remainder of the day.[19]

Lasting effect of Insulin :—

The maximum effect of Insulin in lowering the blood sugar is obtained between 4 and 8 hours after which the blood sugar rises.

Equivalent relation of Insulin with protein and Carbohydrate :—

Approximately 1 unit of insulin oxidises 2 gram of carbohydrate and saves 4 gram of protein acting independently of the normal functioning pancreas[1 2].

Hypoglycaemia :—

When the blood sugar falls very rapidly due to the injection of insulin and when it passes below 0.1 per cent a train of symptoms supervene which are characteristics of this drug. For convenience sake these symptoms may be classified as,

MILD and PREMONITARY symptoms[7] :—

(i) Headache.
(ii) Nausea.
(iii) Subjective feeling of heat.
(iv) Tremor.
(v) Drowsiness.
(vi) A feeling of hunger.
(vii) Weakness.

SEVERE symptoms :—

(i) Motor irritation. (Cramps, Spasms, epileptiform convulsions).
(ii) Extrasystolic irregularities of the heart.

(iii) Visual disturbances (diplopia, convergent spasms).

(iv) Peculiar psychic manifestations (depression, excitement, sometimes aphasia).

So when the blood sugar has reached a level of 0.045 per cent. symptoms of a peculiar nature supervene. These vary somewhat in different animals, but in general may be described as consisting of a state of nervous excitability. In many animals these more or less premonitory symptoms are followed by convulsions in which the animal may throw itself about in a violent fashion. The convulsive seizures last for a few minutes and the animal then lies in a collapsed state with quickly falling body temperature and rapidly shallow breathing, until another convulsive seizure supervenes. These two main symptoms repeat themselves alternately, the coma becoming more and more pronounced and the convulsions feebler until at last the animal dies of respiratory failure, the arterial blood being intensely dark in colour and the muscles instantly passing into rigor mortis[9]; if the blood sugar reaches ·03, the patient passes into unconsciousness and even to death[42].

Treatment :—

(*a*) If the patient can still swallow and absorb, it is sufficient to give a glass of orange juice, or ½ to 1 oz. of glucose, or two teaspoonfuls of sugar in a tumbler of water.

(*b*) If there is unconsciousness or imminent danger, about 30 gm of glucose in 20 per cent or other convenient concentration should be injected intravenously or subcutaneously. These doses may be repeated, if necessary.

(*c*) Epinephrin is not a physiological antagonist of insulin, but, if the liver contains glycogen, it will cause a discharge of this carbohydrate into the circulation. Therefore, 1 c. c. of 1 : 1000 adrenalin solution may be given intramuscularly as an antidote to insulin, in an emergency when glucose is not so quickly available.

In general, however, sugar is to be preferred to any drugs for this purpose[13].

No other sugar, not even levulose, galactose, mannose, which are so closely related to glucose, has anything like the antidoting power that the glucose has[9].

Acidosis and coma :—

The use of insulin in diabetic coma demands much good judgment, courage to act quickly or to wait, and much hard labour to obtain frequent laboratory determinations. In any case of existing or impending coma, the usual routine is to take a blood sample the very first thing and inject 25 units of insulin into the vein before the needle is withdrawn. An additional 25 units is immediately injected subcutaneously.

Further injections of 10 to 20 units of insulin are then given subcutaneously every four hours, according to clinical and laboratory indications.

The facts upon which these procedures are made may be summarised as follows :—

(a) Small doses of insulin frequently repeated are more effective than single large doses.

(b) The maximal result of each dose of insulin usually occurs at the end of four hours.

(c) If the blood sugar is lowered too rapidly insulin shock may occur, even though the level of the blood sugar is still high[18 & 19].

Dangers of Insulin treatment :—

1. Hypoglycosuria and consequent convulsions.

2. High dosage—

The dangers which will probably prove most serious with time are the famliar ones of infection and acidosis. Especially patients accustomed to high dosage may develop sudden acidosis from the cutting off of their insulin supply for a few days, or other trivial accidents, and as the symptoms are sometimes atypical, deaths may occur without diagnosis unless there is laboratory control with both blood and urine tests. Patients should be sought to eliminate most of the fat from their diet if there is a temporary stoppage of their insulin supply or if they develop an infection when away from medical observation.

3. It is dangerous in cases of so-called 'renal glycosuria' or diabetes innocens, in which the kidney fails to hold back the normal amount of glucose in the blood, i. e., the patient is already in a condition of persistent hypo-glycæmia [21].

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DIETETIC TREATMENT OF DIABETES MELLITUS

It is customary with the present-day physicians to divide cases of Diabetes Mellitus into (1) the mild and (2) the severe forms.

By chemical examination of the urine, and test diet, attempts have been made to distinguish the mild from the severe forms of the disease. The dietetic treatment is made to differ in those two classes. In the severe form, it is said that a rigid anti-diabetic diet is not necessary. For my own part, I do not consider a rigid diet necessary even for mild cases of diabetes. It is this craze for rigid diet which is responsible for much harm in this disease.

Recent years have seen something like a revolution in the dietetic management of diabetic patients. Not very many years ago, medical men as a matter of routine practice, used to deprive their diabetic patients of carbo-hydrate foods.

The argument for the withdrawal of carbohydrates from the diet was a very simple one. As the urine contains sugar, it was thought the exclusion of those articles from diet, which are

converted into sugar in the system, would lead to the cure of the disease. Preponderance of proteids—specially animal flesh—entered into the dietary of diabetics. But this did not cure those cases. Extended experience has proved the harmfulness of the reckless administration of flesh-foods to diabetics.

Vegetarian diet for diabetics.

In recent years vegetarian diet (especially, carbo-hydrates) has found favour with a very large number of medical men. Flesh-foods are not considered so absolutely necessary in feeding the diabetic as they were formerly.

It is a fact that diabetic patients who are vegetarians, live longer than those who are meat-eaters.* The importance of the vegetarian dietary

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*In the *Journal of the American Medical Association*, for July 23, 1898. Drs. Reginald H. Fritz and Elliot P. Joslin, published an account of the treatment of diabetes during the past seventy-four years, based on 172 cases treated in the Massachusetts Hospital. According to them, the dietary ordered to diabetics during the period of high mortality, that is, from 1840 to 1855, was as follows :—

"Lean meat, with a small quantity of stale, dry or toasted bread, avoiding all fatty, farinaceous and saccharine articles. For drink, cold water and weak tea"

This clearly proves the harmfulness of meat in diabetes.

in diabetes will be understood if we bear in mind the fact that the *Vitamins are manufactured only by living plants*, notwithstanding their occurrence in certain animal foods.

In a paper on "Diabetes in India," written in 1898, I attempted to account for this by the fact that the kidneys are not so often disorganized amongst vegetarians as they are amongst meat-eaters.* Extracts from this paper are given below :—

Diabetes in India.

"Almost every practitioner in India comes across cases of Diabetes Mellitus lasting for ten, fifteen, and, in some instances, even twenty or more years.

Flesh foods disorganize kidneys.

"Whether we regard diabetes as a manifestation of some morbid condition of the liver, the pancreas or of some portion of the nervous system, it cannot be denied that the kidneys also share greatly in pathological changes in the course of this disease. Death in diabetes, if not brought

*When I wrote this paper, I did not fully understand the role which alimentary toxæmia plays in the causation of the disease. Of course, kidney troubles are not so common amongst residents of India as they are amongst those of cold countries and amongst meat-eaters.

about by some complications, such as pneumonia or phthisis, is almost always due to the kidneys not discharging their functions properly.* The closing scenes in diabetes always point to the mischief in the renal apparatus.

"If we bear this fact in mind, we shall be able to understand the longevity of diabetic cases in India, and also to rationally treat the disease.

"In the first place, the kidneys have not to perform so much work in India as in Europe and other cold countries. The chief function of the kidneys is to remove impurities from the blood. In India, the skin largely shares in discharging

* As regards the kidneys, the fact that they are so commonly found to be hypertrophied in diabetes shows that their reserve power is already used up; and it would therefore be expected that diabetic patients with any form of renal disease might exhibit symptoms from which those with healthy kidneys are free. That that is actual the case is illustrated by the sudden œdema which sometimes follows the administration of sodium bicarbonate to patients who are being dieted on oats. According to Thies, the functional activity of the kidneys depends on a definite relationship between the ions of soldium, potassium and calcium, in the renal epithelial cells; and this is apt to be disturbed by an undue preponderance of sodium ions as a result of an infusion with solution of sodium chloride. Even with healthy kidneys, renal insufficiency may follow a saline infusion: and when the kidneys are

this function, and so the whole strain is not put on the kidneys.

"In the next place, kidney disease is not so common amongst Indians as amongst Europeans. This is due to Indians being accustomed to the vegetarian diet, which is non-stimulting, and also to their eschewing alcoholic beverages. Alcohol-consumers have to pay the penalty in diseased kidneys.

"The marvellous residual kidney power of the natives of India is the key-note of the longevity of cases of diabetes amongst them. They retain their kidney power unimpaired, from their vegetarian diet and nonalcoholic drinks, and also the fact that they keep the pores of their skin open by frequent baths.

Residual kidney power of Indians.

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diseased the effect is the greater, as the renal cells are then already overloaded with sodium ions, and are therefore more or less on the verge of insufficiency. The administration of foods (such as oatmeal or rice) which contain little sodium chloride, but are rich in other alkaline metals, may counter-balance this preponderance of sodium, and promote diuresis with effect; but if at the same time sodium bicarbonate be given as a medicine, the increased diuresis would be hindered by an overloading of the renal epithelium with sodium and in diabetic patients with renal disease it may give place to renal insufficiency and consequent dropsy—*B. M. J.* (*Epitome*) Dec. 7 1912, p. 84.

"Not losing sight of the fact that in diabetics the kidneys become sooner or later diseased, our course of treatment should be such as not to throw undue strain on them. In the treatment of diabetes, the regulation of diet plays the most important part. With many practitioners, the administration of animal food is the chief treatment of diabetes. They believe that such food is not converted into sugar and thus the cure of diabetes is to be hoped for. The reckless prescription of animal food has been often followed by serious consequences. The writer has known practitioners giving animal food to diabetics who had never tasted flesh before. The patients, instead of improving, sank rapidly and died. It has not been proved that animal food checks the course of the disease. Such being the facts, its use should not be insisted upon by those who are accustomed to it. Moreover, meat diet is not the proper thing for patients suffering from any renal disease. This diet throws undue strain on kidneys; hence it should be very cautiously given to diabetics.

Kidneys should not be unduly taxed

"From vegetable diet, on the other hand, much

good is to be expected. It is non-stimulating, and does not throw unnecessary strain on the kidneys. Of course, such vegetables as are rich in starch and sugar should be excluded. In India, where the people are chiefly vegetarians, diabetic patients should be prescribed vegetarian diet."*

Why vegetable diet is beneficial in diabetes.

In diabetes there are skin affections, as boils and carbuncles, brought about by the blood be coming deficiant in proper alkalinity. To make it properly alkaline, vegetable diet is of paramount importance. Vegetable salts keep the blood alkaline.

Residents of Europe and America, who are mostly meat eaters, generally suffer from consitpation and other ailments which are due to it. It is a well-known fact that the thirst of the diabetic

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*Dr. Arany writes :—

"*Vegetables* should be the diabetic's principal article of food (1) on account of their proteids being better tolerated by the patient than those of animal food : (2) because they are very good carriers of fat : and (3) owing to their filling the patient's stomach up whereby the diabetic's stomach hunger gets more satisfaction than if an amount of meat, corresponding with the calories of the vegetables, were ingested by him." [The *Lancet* for March 19, 1923, p. 386.]

is increased by constipation. Vegetarian diet not only keeps the bowels regular and thus relieves constipation, but, on account of its containing a large amount of water, does not make one feel so thirsty as a meat diet does. For the relief of the thirst and constipation of the diabetic, a vegetarian diet is indicated.

All the above shows the necessity and value of vegetables in the dietary of the diabetic.

Articles of food allowed to diabetics.

Formerly all kinds of meat (except sweetbread and liver), fish, poultry, game and eggs were considered good for diabetics. But shell-fish, containing a large amount of carbo-hydrates, were forbidden. Animal food, for reasons stated above, should be, as far as possible, withheld from the dietary of diabetics. However, those who are accustomed to it, may be allowed to partake of it in moderation. For them, fish especially, will be found very useful. Bread made from fish roe containing Vitamins is given with advantage. This is made from the roe of fresh water fish being dried and ground, and then cooked in the usual fashion.

Carbo-hydrates in Diabetes.

The importance of carbo-hydrates is now recognised, and they are not withdrawn from the dietary of diabetics as it used to be not very many years ago. In India' the people do not live such active lives as in cold countries, hence there is less waste of tissue, and consequently the demand of proteins should be also less. The demand for fat also is less, for there is small loss of bodily heat. The cheapest source cf muscular energy is undoubtedly carbo-hydrates.

Several methods of diabetic cure by means of different carbo-hydrates are now practised. But before describing these, it is necessary to allude to the larger excretion of sugar in the morning hours than at any other time of the day. There is, at present, no satisfactory explanation of this phenomenon. Dr. Naunyer's explanation is that "in the empty intestines the introduced carbo-hydrates more quickly digest and absorb, and so the diabetic organism is supplied with more sugar at once than it can assimilate." But Dr. Haig contends against this, and says that sugar follows the uric acid, rising when it rises, and falling when it falls, and so there is a larger excretion

of sugar in the morning hours when the excretion of uric acid is large. Be the explanation what it may, this phenomenon has an important bearing in regulating the diet in reference to time of day. Carbo-hydrates may be withheld if possible, or given in very small quantities to diabetics during the morning hours.

On the other hand Dr. C. D. Shapland writes in the Lancet, September 18, 1926., P. 589 :—

"that the blood sugar rises towards the late afternoon both in normal and diabetic subjects. The causation of this is not clear. It can hardly be ascribed to the carbohydrate intake at the afternoon meal It is probable that about this time of the day there is a mobilization of the glycogen reserves of the body with a consequent increase of the amount of the circulating glucose, though the possibility of this rise being due to the gradual production of sugar derived from protein metabolism must also be considered."

In recent years, some articles of food, rich in carbo-hydrates, have been recommended by some medical practitioners as specific cures for diabetes,

which seem to be based on the principle enunciated by Von Noorden's school that "the most efficient means for combating acidosis in diabet s is the abundant administration of carbo-hydrates."*

The limitation of carbo-hydrate to one particular kind.

Whether it is the rice cure of Duering, the milk-cure, the oat-cure or the potato-cure on which we fix our attention, we find that underlying them all, there is a common principle, namely, the limitation of carbo-hydrate to *one particular* kind, excluding all others, and att he same time the exclusion or the maximal reduction of meat * * * It is of tremendous importance to possessing, as in the oat-cure, a means of mastering large quantities of acetone bodies within a few days. Even though we may not be able to permanently maintain this favourable state of affairs, it is still of the greatest advantage to the whole organism to be given a period of about a week or a fortnight in which the tissues are practically free from acetone."

For my own part, I do not understand the *rationale* of Von Noorden's recommendation. It

* *The acid Auto-intoxication*, p. 74.

may be that the limitation of carbo-hydrates to one particular kind will make the diabetic take less quantity of food than usual, thus minimising the evil consequences of over-indulgence. But this is hardly beneficial to the diabetic. His dietary should be as varied as that of a healthy individual : monotony in diet is not calculated to do him good.*

Carbo-hydrates are essential to human life, and therefore, they should not be withdrawn from the dietary of the diabetic. Truly has Dr. M. C. Ridwill, of Melbourne University in his paper on " Rye bread in Diabetes,"† observed :

" I would like to say here that we must not be carried away by the analysis of food-stuffs given in books. The chemical means of analysis are not the digestive means, so that when we see a food marked as containing 70 per cent., of starch we must not consider that the body ferments can

*Sajous has very truly said, "The diet should be varied to avoid the presence in the blood of a relatively large proportion of one waste.". (*Internal Secretions,* Vol. II. P. 1596.)

†The beneficial effects of rye bread in diabetes are due to the fact that in the milling of rye there is no separation of the germ containing Vitamins.

extract the equivalent in glucose of 70 per cent., of starch."

According to Schultzen and some other investigators sugar is eliminated unchanged in diabetes, because the ferment is lacking which normally splits sugar into lactic acid and glyceric aldehyde. The withdrawal of carbo-hydrates and the administration of flesh-foods will not generate the sugar-splitting ferment in the system.

It is said by many physicians that wheat starch is not borne well in diabetes, hence they recommend such carbo-hydrate food-stuffs as mentioned below.*

Banana cure.

(1) It is desirable to administer in diabetes such carbo-hydrates as lead to their perfect utilization. No carbo-hydrate is better calculated to serve this end than the Banana starch.

The plantain meal is better than other starches,

*There is no evidence that wheat starch is more injurious in Diabetes than any other starch. Its harmful effects are due to the popular preference for white bread, the flour for making which is obtained by passing the meal through a very fine sieve It is thus very poor as a nourishing food, for it contains hardly anything but starch and cellulose. Vitamins are also removed.

on account of the protein compounds it contains. Moreover, as stated in *The Lancet* for February, 1900 :—

"For some reasons, not yet explained, the starch of the banana is much more digestible than are the cereal starches,"

Banana flour is made by drying and grinding the fully grown unripe banana, that is, before the starch is changed into sugar in the ripening.

Banana flour.

To make banana bread, it is necessary to mix a considerable quantity of wheat flour with banana flour. A loaf from the banana flour is prepared by making a paste of it, and then submitting it to the action of steam under pressure.

Bananas may be eaten by being split in half and filled with grated cocoanut. This preparation is relished as much on account of the banana as of the rich sauce of cocoanut milk. Stew of unripe bananas prepared with cocoanut gratings is used with advantage in diabetes.

The banana, however, should not be the exclusive diet of a diabetic for any length of time. It is deficient in protein and water soluble Vitamin. Hence it is necessary to take with it such articles

as a little casein and yeast or carrot extract, so as to make it a sufficient diet for the purposes of growth and maintenance.

Rice cure. (2) Rice cure has been recommended by Duering.

The beneficial effects of rice cure are very easily accounted for ; of all the cereals it is the one which taxes the kidney least, and because its consumption in moderation does not produce alimentary toxæmia.

But then rice should not be polished,* and there should be proper methods in its cooking. Only so much water is to be put in the rice to be boiled as will suffice to cook it. To strain off the thickened rice water after cooking, is not the Japanese practice, nor of the sturdy cultivators of Upper India.

Two points should be observed in the employment of rice cure in diabetes, *viz.*—

1. The rice should not be polished ; and

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*Dr. J. Walter Leather, Imperial Agricultural Chemist, India, writes : —

"The meals and broken rice are, chemically, the best foods, and the polished rice contains less oil, proteids, and phosphorus. Consequently, one is apt to condemn the polishing process. But the consumers hold that one

2. The thickened rice water, after cooking, should not be strained off.

The following preparations of rice, then, are useful in the treatment of diabetes :—

(*a*) *Khai,* Hindi *Khil.* (*b*) *Chinde,* Hindi *Chiura,*
(*c*) *Khichri.* (*d*) *Choru.*

The late Babu Partapa Chandra Ghosha, the distinguished scholar of Calcutta and Vindhya-chala, described the above preparations in the *Statistical Reporter* for 1874 (a journal which was at that time conducted by the late Mr. Robert Knight) as follows :

"(1) Khai is parched paddy. Paddy when parched on fire loses its water, and becomes an-hydrous, and swells up into about four times its diameter. It is then very light, and very white in appearance. In parching, the husk is split and separates itself from the dessicated swollen grain.

"(2) *Chinde* [Hindi, *Chiura*] is flattened paddy. Paddy is well-boiled, and when slightly dry, it is

cannot cook unpolished rice, which concludes the argument! It follows that rice should be consumed in conjunction with other grain, particularly pulses, which, indeed, is very commonly the case" (Annual Report of the Board of Scientific Advice for India, for the year 1913-14, p. 13).

put under the *dhenki.* Soft paddy, so subjected, is flattened by the heavy pestle of the *dhenki,* and is husked at the same time.

" (3) *Khichri* is rice boiled with *dal.*

" (4) *Choru* is rice boiled with milk, sugar and *ghee* ; it is rarely used as food. It is cooked for oblations to the gods and manes of the dead.

In the interior, a kind of *choru* with different proportions of *ghee,* is made and eaten ; it is then *ghee-payasa.**

Rice may also be given in the form of bread which can be made by incoporating one-fifth rice flour.

Oats in Diabetes.

(3) In this country, at least in the Upper Provinces, oatmeal is not generally used as food by the people, but is given to horses for fattening them. There is prejudice against using it and living on it for days together.

* I have known and seen cases of Diabetes benefited by choru. Dr. Langdon Brown says that "if patients were allowed starch which had been cooked in fat, there was a much slower appearance of sugar than otherwise." (B. M. J. 19th. November, 1921, p. 844). This perhaps explains the beneficial effect of choru.

Its author, Dr. Noorden, does not claim that oatmeal treatment will cure diabetes. According to him, it will at most lessen the dangers of that disease.

It is said that there is Insulin like action of oat-meal bran extracts.

Potato cure.

(4) Potatoes were, and still are, forbidden by many to the diabetic. Yet it is a remarkable fact that its use has been recommended by many in diabetes.

It has been shown that diabetics can take 3,000 grains daily in the form of potatoes, without eliminating more than 500 or 600 grains of glucose in the urine The benefit of the potato diet is ascribed to the alkaline salts, especially potassium, contained in the potato. The usefulness of the potato in Diabetes Mellitus may be due to the fact that its consumption reduces the acid output. Referring to this, Prof. Graham Lusk says that this "should establish the potato upon a high plane of dietary dignity." (*The Science of Nutrition*, 3rd. Edition, p. 361).

Potatoes should be cooked by steaming with the skin on. It is proposed that the bread

difficulty in diabetes be met by using the " flour " of properly cooked potatoes, instead of the flour of grain. Excellent and delicious baked cakes can be made from paste composed of a kind of flour prepared by rubbing down potatoes cooked with their coats on by steaming, blended with cream and butter. Sir J. Sawyer gives the following details for the making of these new biscuits and bread for diabetics :—

Bran and Potato Bread.—Take half a pound of flour of steamed potatoes, quarter of a pound of bran, half an ounce of German yeast, half an ounce of butter, one egg. Twenty-four hours before making the dough, cook the potatoes by steaming them in their " jackets, " then peel and break up into flour with the fingers. Mix all ingredients together, and let the paste stand near the fire for an hour to " rise. " Bake in greased tins for an hour and a half. "

I have tried the potato in some cases of diabetes. But, if it did not do any harm, it did not appear to do much good either to the patients.

As substitutes for rice and wheat, different

kinds of millets have been used in the dietary of diabetics. These are used in the form of porridge and of *chapatis*. There is a larger percentage of oil in millets than in wheat or rice. This, perhaps, accounts for their usefulness in diabetes. Millets are also rich in Vitamins A. B.

The use of millets in diabetes.

Bread being also a carbo-hydrate was, and is, under the ban of many medical men ; and so, many substitutes for ordinary bread were recommended for diabetic patients.

Bread substitutes for diabetes.

Gluten bread was formerly very extensively used in the dietary of the diabetic. But it has fallen into disuse, because it is unpalatable, expensive, and by no means free from starch. Bread made of almond flour, cocoanut flour, *besan* or flour of several varieties of *dals*, which are not only palatable and inexpensive, but contain less amount of carbo-hydrates than gluten, could be very advantageously used as substitutes for ordinary wheaten bread, if so desired.

But it is not always necessary to make use of bread substitutes for diabetics. Most of them can

and do tolerate ordinary wheaten bread better than its substitutes, provided that bread is not lacking in vitamins and mineral salts. I have found wheaten cakes fried in *ghee* or clarified butter, called *luchi* in Bengal, or *puri* in Northern India, very useful in diabetes.

The use of Inulin Biscuits.

Since diabetics can assimilate inulin—a form of starch found in tubers cf several species of *Inula*, such as that of *Inula racemosa*, which grows in the Western Himalayas, on the borders of fields, &c , Kashmir, and Spiti—it has been recommended to be given in the form of biscuits.*

Dr. Hale White suggests that the tubers may be cooked and eaten as a vegetable.

Garlic tubers contain inulin. These may be also cooked and eaten as a vegetable in diabetes.

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* The root of *Kasni* (Cichorium intybus) contains 36 per cent. inulin, and may be made into biscuits.

" Inulin administered to phlorhidzinized dogs does not give rise to glucose. The feeding of levulose to the same animals results in the elimination of large amounts of glucose. It is concluded that inulin is not, to any appreciable extent, converted into levulose or any other substance capable of forming glucose in the diabetic organism." *Chemical Abstracts* for June 10, 1914, p. 1979.

Roasted products and their applicability in the therapy of Diabetes Mellitus.

"Rice, bread and potatoes when roasted or caramelized are changed in character and are anti-ketogene and anti-glucosuric. A good working diet for diabetics, rich in calories, but causing little glucosuria, can be formed with these roasted carbohydrates in combination with inulin or vegetables containing inulin, levulose and a considerable amount of fat."*

Gautier writes :—

Fruits to diabetics.

"Fruits, properly so-called, particularly those of the Rosaceæ (peaches, apples, apricots, pears, strawberries, raspberries,) containing as a rule, only 5 to 6 parts of sugar and 1 to 7 of starch per 100, may, in case of necessity, be tolerated, *provided they are not taken in excess,* as 100 to 150 grms. per day do not introduce more sugar than 10 to 15 grms. of bread do. Moreover, half of this sugar is in the form of levulose, which rapidly disappears from the blood. The same may be said of the orange, lemon, pomegranate, etc."

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*C. A. Vol. XIX. No. 4 (Feb. 20, 1925) p. 668.

" With still more reason, may those fruits, which contain scarcely any sugar or starch, be sanctioned."

In India, besides the above, such fruits as *mangoes*, *jambul*, *khirni*, *phalsa*, *lasora*, *papaya*, *bael* (*Ægle marmelos*), *kaitha* or *kathbael* (Feronia Elephantum), Zizyphus vulgaris and jujuba, Averrhoa Carambola, Anacardium Occidentale, and Semecarpus Anacardium may be given to the diabetic with advantage. The fig also is useful to the diabetic. Its nourishing nature is evident from the fact that in Calabria and other parts of Southern Italy fresh or dried figs form almost the entire diet of the labourers, who are nevertheless able to perform the hardest labour. The date is also useful in diabetes, because it has a high vitamin content, and date sugar is easily assimilated.

Substitutes for sugar.

While there is difference of opinion regarding the prescription of starches to diabetics, most of the authorities are agreed that sugars—saccharose and glucose especially—should not be given to them. Diabetics crave for something to sweeten their foods and drinks with. Saccharine has been

proposed to satisfy their craving. This is a coal-tar product said to be 300 times sweeter than cane-sugar. But at the same time it is a poison. It may be used as a medicine, but not as a food.*

Sucrol, a paraphenctol-carbamide, has been also proposed as a substitute for sugar, but this also cannot be given in large quantities, as it gives rise to unpleasant symptoms.

Glycerine has been proposed as a substitute for sugar. But its administration also is known to increase glycosuria.

Levulose, erythrite and inosit may be used as substitutes for sugar. But these are very expensive stuffs.

In India, many diabetics take cane-sugar and they do not seem any the worse for it. As I

Sugar in diabetes.

look upon diabetes as a manifestation of alimentary toxæmia, I do not see any harm in the administration

*" *Substitution of saccharin for sugar.* The three functions of sugar are as (1) a sweetening agent, (2) an energy producer, and (3) as an agent to increase the oxidation in the body. The ingestion of saccharin will increase the oxidation in the body as measured by the catalèse content of the blood. It produces more extensive

of cane-sugar in moderation; but it should not be given in such quantity as to increase toxæmia. Cane-sugar strengthens cardiac muscles and serves to stimulate the flow of gastric juices and, therefore, acts beneficially in diabetes.

Honey in Diabetes.

Practitioners of Hindu and Græco-Arabic Schools of medicine give honey to diabetics with many of their medicinal preparations. Since honey consists of levulose, it is not harmful in diabetes.* Honey taken by itself has a bad effect on the teeth, but this is counteracted by adding 1 p. c. tartaric acid to it

Honey contains a diastatic ferment which transforms soluble starch into sugar. It also contains a special protein secreted by the bee, which, when inoculated into rabbits, causes the formation of antibodies in the blood serum. The ferment and the special protein, as well as the

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catalese than the sugar. It may be positively useful in diabetes, which is attended with defective oxidation."

C. A. XIII. No. 7 (April 10, 1919 p. 748.)

* "From a study of 7 cases, Davidoo claims that honey is a good substitute for other sweet foodstuffs in diabetes. It prevents acetonæmia and diminishes the amount of sugar in the urine in spite of the fact that honey

vitamins in it, perhaps account for the beneficial action of honey in diabetes.

Gums in Diabetes.

Some of the edible gums may be given with advantage to diabetics. Acacia gum, fried in *ghee*, has proved of use to sufferers from diabetes. It is very palatable and useful, for it is not converted into sugar.*

Levulose, erythrite and inosit may be used as substitutes for sugar. But these are very expensive stuffs.

Fats and Oils in Diabetes.

Diabetics, as a rule, suffer from sub normal temperature, and when they have fever, their urine is generally free from, or contains a very small amount of, sugar.

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contains 74 per cent sugar."—*Chemical Abstracts* for Decemder 10, 1915, p. 3278.

**The Housewives' League Magazine* of New York for 1914 published an article entitled 'The Story of Chewing Gum."

It is stated there that 'gum-chewing is admitted to be a habit of American origin, and is attributed generally to American nervousness; but there is another and quite rational reason for its use. Spanish explorers reported that they found the Indians five hundred years ago using

The food, which a healthy person takes in the course of 24 hours, represents between 2,500 and 3,000 calories: but the diabetic requires more, since he voids large quantities of urine containing sugar. One gramme of sugar representing about 4 calories, a loss of 300 grammes a day, means that 1,200 calories have to be replaced. It is calculated that one gramme of protein represents about 4 calories, whereas the same amount of fat about 9. So the diabetic, losing 300 grammes of sugar a day by his urine, has to take extra 300 grammes of protein or 135 grammes of fat to cover his loss.

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the gum of the Spodillo to relieve exhaustion and quench thirst The Indians probably did not chew the gum as their descendants to-day do not chew it. They only hold it in the mouth, which has the effect of provoking a flow of saliva and thus keeping the throat moist in the absence of water.*** In Greece, it is said to be dispensed as a regular ration to the army.*** Who shall say how much this humble confection had to do with the fall of the Turks. (*Literary Digest* for October 17, 1914, p. 797.)

The beneficial effects of gums in diabetes are probably due to the enzymes they contain. According to F. Reinitzer (*Jour. Chem. Ind.* 15th October, 1909) there are at least three enzymes, *viz.*, an oxydase, a peroxydase, and a diastase present in gums, though, in some gums, all three enzymes may not be present.

Fatty foods should, therefore, be given by preference.

Brain and spinal cord of slaughtered animals are free from carbo-hydrates and rich in protein and fat. They should be reserved for invalids as diabetics.

Absorption of Fats.

Fats with lower melting points are, more completely absorbed than those with higher ones. Thus, 97½ p. c. of Butter, 92 p. c, of Bacon, and 90 p. c. of mutton-fat are absorbed as their melting points are 37°C., 48°C., and 52°C. respectively.

The high fat diet not only stops the glucosuria but also reduces the level of the blood sugar to normal.

"The dearness of fat is unfortunate, aud is not uncommonly a source of trouble in practical dietetics. One might mention, as an instance, the difficulty which a diabetic, who has at the same time the misfortime to be a poor man, finds in providing himself with a diet suited to his disease. The same remark applies, though less forcibly, to proteid (Hutchison, Foods and Dietetics, p. 17).

"A cocoanut (weighing 1¼ pounds) contains ¼ pound fat. Its price is about 2d. so that as a source of fat it is equivalent to butter at 8d. the pound." *Ibid* p. 259.

Fats and oils have been proposed as substitutes for carbo-hydrates in feeding the diabetic. It should be remembered that carbo-hydrates and fats cannot be substitutes for each other indiscriminately, as each has its specific action on the whole metabolism of force and matter, which is a factor of great importance for their role as food. When the liver is affected, that is, when diabetes is due to liver disorder, food which does not undergo secondary digestion in that organ, should be given. Fats, therefore, are very useful in diabetes, since the liver is not unduly taxed for their digestion. Fats, as said before, are our sheet-anchor in the dietetic management of diabetes. These may be derived from the animal or the vegetable kingdom. Butter, cream, cheese, yolk of eggs, bonemarrow, vegetable oils, nuts and other oleaginous seeds may be very usefully given to diabetics. The fat-soluble Vitamin A which acts as a stimulus to the assimilation of food is very useful in diabetes. Such fats as contain it in abundance should be given to diabetics. But it is necessary to remember that fats, without the addition of carbo-hydrates, may produce acetonuria.* Regarding butter, the

*Ch. Ab. XIV. No. 4 (Feb. 20, 1920) p. 425.

authors of the monograph on "The Acid Auto-Intoxication" say:

"Butter gives the highest values for acetone excretion of all the fats that we eat. Von Noorden has called attention to the fact that this deleterious influence, that large quantities of butter exercise, can be reduced if the butter is first thoroughly washed with cold water; for in this way the lower fatty acids are removed and they exercise the greatest influence on the acetonuria. If the butter is thoroughly washed, quantities as large as 180, or even 200 grams, can be given without causing any appreciable increase in the acetone excretion, and we will hardly ever be tempted to give more fat than this."*

Clarified butter, known as ghee, can be given with more safety than butter.

No fat is required if a sufficient amount of fresh vegetables and fruits be eaten daily to satisfy the vitamin requirement.

*L. C., pp. 73-74.

Again the composition of the fats, determines the rapidity and extent of their digestion. The fats having lowest melting points, are assimilated soonest and in the largest quantities.

In his monograph on Diabetes Mellitus, Noorden says :—

" The question, as to whether fats also play a part in the formation of the sugar, is a much more difficult one to answer. For the one component of fat—the *glycerin*—the question may be at once answered in the affirmative.*** Glycerin increases glycosuria, both in severe cases of diabetes in man, and in dogs after extirpation of the pancreas. *Lecithin* which contains a fair amount of glycerin behaves in the same way." (P. 75.)

Acetonuria how produced.

Fats are, no doubt, our " sheet-anchor " in the dietetic treatment of diabetes for the production of sugar from fat has not yet been demonstrated,* But fats cannot be given in very large, or in isodynamic quantities, as substitutes for carbohydrates. Moreover, it has been found that ingestion of certain kinds of fats often leads to acetonuria.

In its issue of 31st January, 1925, the Journal

* " One by one the bulwarks of the doctrine of conversion of fat into glucose have been shattered, and it may now be relegated to the realm of scientific superstitions." (Lusk's Science of Nutrition, 3rd edition, p. 437).

of the American Medical Association writes in an editorial article :—

" Diabetic lipæmia is becoming a familiar expression, With an excess of fat, Joslin has written, 'diabetes begins, and from an excess of fats diabetics die'......the blood fat is above normal with a consistency equal to the changes in blood sugar in diabetes......Incidentally, it may be noted that a knowledge of the content of blood fat may aid materially in the diagnosis of renal glycosuria, for the latter may be ruled out whenever there is a coincident lipæmia of excessive proportions."

The bio-chemistry of fat is not yet fully known. The manner of its digestion, absorption and assimilation is also not well understood. The pancreas is the most important organ concerned in the process of fat absorption. The pancreatic fluid, being alkaline, emulsifies, and its fat-splitting ferment produces the saponification of the fats. The bile acting in conjunction with the pancreatic juice is of great importance in the absorption of fats. If from any cause, such as extirpation, or disease, of the pancreas, the normal amount of the pancreatic juice is diminished, reduction in absorp-

tion necessarily follows. The walls of the intestines have also a great deal to do in the assimilation of fats. It is found that 97·7 per cent of olive oil is absorbed and that milkfat is assimilated even in the absence of the pancreatic juice.

As many cases of diabetes are due to the pancreas being at fault, it is necessary to give them such fats and oils as they can easily digest, absorb and assimilate. By paying due attention to these points, in the administration of fats, acetonuria will be reduced to a minimum.

Milk in Diabetes.

By some, milk is considered to be very useful in diabetes, so much so that there is the system, known as milk-cure, of diabetes. In this system, which was much practised by Dr. Scott Donking, the food is limited to "skimmed" milk. At first the patient takes four to six pints in 24 hours, gradually increasing it to 12 pints. Part of this milk is converted into curds and whey, and taken as such. According to Dr. Donking, by placing

*In the B. M. J. E. of March 18, 1922, p. 44. is noticed "The Sparing Action of Fats on the Destruction of Albumin in Diabetes."

a patient on milk diet, sugar entirely disappeared from the urine at the end of a fortnight.

But this exclusive milk diet has not found favour with the medical profession generally.

Milk contains four per cent. of sugar, called lactose, and a very large amount of water—which it is said, makes the condition of the diabetic worse. Artificial milk from which sugar has been removed, has been suggested for diabetics. But milk-sugar, introduced in the blood, is eliminated unchanged in the urine. Its usefulness is due to the presence of lactose. It is not a glycogen-former and, therefore, not harmful in diabetes. It however, contains a large quantity of fat and albumen, which cannot but benefit diabetics. So cream may be given with great advantage to them ; it contains less milk-sugar, but a large amount of fat.

It is a mistake to look upon milk as a complete food. In considering the value of a food, too much stress should not be laid upon the amount of fat, proteid aud carbo-hydrate or its calorific value, but equal attention should be paid to the amount of inorganic substances contained in it. It is a fact that milk has a very low iron content. Iron

is rightly looked upon as playing an important part in the nourishment of the human organism. Milk contains less iron than many other articles of diet. Hence an exclusive milk diet is not beneficial in diabetes.

The number of different salts is greatest in goat's milk. The phcsphates in goat's milk are combined with more bases than in any other milk. The protein of goat's milk is more easily digestible than that of cow's milk. Goat's milk is, therefore, to be preferred in dieting diabetics.

Goat's Milk in Diabetes.

Milk is not easily digested by many. It produces flatulence, which is a very common cause of alimentary toxæmia. It is advisable, therefore, not to prescribe it indiscriminately in all cases of diabetes.

Then, again, boiled or pasteurized milk is not good for nourishment. There is a great deal of truth in what Sir Ray Lankester writes in his "Diversions of a Naturalist" (p. 300), regarding the supply of pure milk. He says :—

"The lactic 'souring' of milk is not injurious, but, on the contrary, a safeguard. It actually

prevents the growth in the milk of other really harmful and deadly germs. Thus when the lactic germ is not there, but killed by heat, these other deadly germs get their chance."

From all these considerations, an exclusive milk diet should not be prescribed in diabetes.

Vegetable milk better than ordinary milk, rich in vitamins, ferments much less readily than cow's milk and contains easily digestible emulsified oil is useful in diabetes, rickets, nephritis etc.*

Curds of milk, in which sugar has been partly converted into lactic acid, are useful in diabetes. *Koumis, kefir, laben* and those preparations of milk in which the sugar is got rid of by fermentation, may be prescribed with advantage to diabetics. It is also said that lactic acid ferment destroys sugar. But the true explanation seems to be that lactic acid ferment brings about the rapid cleavage and solution of proteid foods before their decomposition by intestinal bacteria.

**Preparation of vegetable milk* ; Sweet almonds (100 g.) are finely ground, mixed with 20 p. c c. of H_2O, kept in icebox overnight and squeezed in a press or through 4 layers of gauze. The filtrate is diluted to 300 c. c. with water.

Whey in diabetes.

Whey is useful in diabetes, because it relieves alimentary toxæmia. It is on that account that Metchnikoff attributes the longevity of Bulgarian peasants, who consume large quantities of this food. In Europe, the importance of whey as an article in sick dietary has been recognized only in recent years; but Hindu physicians knew its usefulness so well that they compared it to nectar or water of immortality.

Green Vegetables in Diabetes.

It is because green vegetables contain a large quantity of salts that their use is recommended in diabetes. These relieve constipation, which is one of the most distressing symptoms in this disorder. They are useful, because the starch they contain is converted into levulose. Green vegetables are rich in potassium salts and, therefore, their use prevents acidosis. Moreover, the leafy parts of vegetables are the best source of vitamins. Tomatoes and cabbage leaves are rich in all the three vitamins and hence very useful in diabetes.

Use of vegetable milk, Ch. Ab. XII No. 17 (September 10, 1918) p. 1793.

Vitamins in Diabetes.*

The role which the shortage of vitamins plays in the causation of diabetes, has not been laid stress upon by the medical profession in any country of the world. If we look upon diabetes as a disease of nutrition brought about somehow by the action of the ductless glands, then the influence of vitamins in this malady will be easily understood ; for they stimulate the secretions of the various glands, such as the thymus, thyroid, &c., by which nutrition is influenced and health is maintained. Foods deprived of vitamins lead to faulty nutrition.

Some medical practitioners have found Rye bread useful in diabetes, the beneficial effects of which are due to the fact that in the milling of rye there is no separation of the germ containing vitamins.

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*In its issue of November, 22, 1924, in an editorial note, the *British Medical Journal* (p. 901) writes :—

"Ogata has fouud that in birds fed on a rice diet the islands of Langerhans at first undergo hypertrophy, showing an increased demand for the products of these cells. The hypertrophy may be succeeded by atrophy, if the diet be persisted in. The atrophy, it is believed, is

Scurvy, which is called a deficiency disease, is, by no means, a rare occurrence in diabetes. In the *British Medical Journal* for Jan. 26, 1907 (p. 197), Mr. W. E. Jones, M.R.C.S., L.R.C.P, of Blackfriar, mentions a case of a boot-maker, aged 44, who was discovered two years previously suffering from diabetes. He was prescribed anti-diabetic diet, having " absolutely no vegetables of any kind, but fresh cooked meat in abundance." On this diet, he showed marked signs and symptoms of scurvy. But with a plentiful supply of fresh vegetables and lemon juice, as well as lime juice, both his scurvy and diabetes disappeared.

Cassimar Funk thought that these bodies contain amines which are nitrogenous compounds without any phosphorous. He considered them necessary to life and therefore called them "vitamines" and even gave a formula for them.

But their chemical composition is unknown, as

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due in great part to want of Vitamins B. This raised the question whether chronic lack of Vitamins B may not ultimately cause diabetes.

" Since the amount of Vitamins B needed is proportioned to the quantity of Carbo-hydrate eaten, it would, seem likely that chronic-deficiency of Vitamin B is also a factor of importance in the production of the disease."

they are very unstable bodies and occur in minute quantities. So far as at present known, they are not synthesised by animals but are obtained by them from the vegetable world only.*

In *The Elements of the Science of Nutrition* (Philadelphia and London, 1919), Professor Graham Lusk of the Cornell University Medical College writes that the chemical composition of the "Vitamins will some day be known, even as the chemical composition of Epinephrin is known. Epinephrin, an essential of life, is present in the blood to the extent of one part in 100,000,000. In like manner, vitamins which are present in meat, milk, green vegetables and grains are essential to the harmonious co-rrelation of the nutritive functions of animals. Lafayette Mendel first suggested the use of the word 'hormone' in connection with the vitamins. Gowland Hopkins adopts the term 'exogenous hormones'. The expression 'food hormones, would also be exactly descriptive of the nature of these substances" (3rd Edition, p. 378.

The British Medical Journal of 21st January, 1922, contains an Editorial Article on "The Sources of Vitamins" which is commended for the perusal of those who are interested in the subject.

The mode of action of vitamins also is not properly understood. It is thought that they act as "the keys to the doors of the otherwise closed food stores" or as "catalysts in certain normal processes of metabolism." Regarding the importance of vitamins, Harry A. Mount writes in the *Scientific American* of July 30, 1922, "that we may be enabled to wage such a successful fight against old age that a man will still be 'young' and virile at a hundred. The agency which promises this miracle is the mysterious food element which scientists have named 'vitamins'."

Vitamins are mostly divided into three, called Vitamins A, B & C. Vitamin A is a fat soluble, such as is obtained from milk It acts as a stimulus to the assimilation of food, hence useful in diabetes. Vitamin B is a water soluble, such as is obtained from green vegetables; Vitamin C is also a water soluble such as comes from oranges and lemons. Vitamin A is also named Antirachitic; vitamins B & C are named Antiberiberi (or Antineurotic) and Antiscorbutic respectively.

Wheat or rye, sprouted until the shoot extends an inch beyond the grain and heated in water to

70° to gelatinize the starch, forms a cheap, convenient and palatable source of vitamins. Prolonged cooking of fresh foods should be discouraged.

In the dietetic treatment of diabetes, it is no longer sufficient to merely consider the question of proteids, carbo-hydrates and fats, but the importance of mineral salts and vitamins should be equally taken into account.

It is to a shortage of vitamins, and not to underfeeding to which should be attributed many conditions of disease. If starvation and fasting are to do good in diabetes, it is necessary that the less the amount of diet, the more rich it should be in vitamins.

The relation of vitamins to diabetes will be evident from the fact that it is found from experiments on animals that **a vitamin-free food causes a distinctive rise in blood sugar.** This disappears after the administration of vitamins.*

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* Moreover Mr. R. Adams Dutcher, in his 'Vitamin Studies,' published in the *Journal of Biological Chemistry*, Vol. XXXVI, states that—

"Vitamins function, directly or indirectly, in the stimulation of oxidative processes, thereby clearing the tissues of toxic materials."

Yeast has been found very useful in diabetes. This is no doubt due to the fact of its having a very high vitamin content.

Vitamins influence metabolism. Extracts from sweet potatoes in not too large quantities diminish the sugar in the blood and the urine.

There is anti-diabetic substance in sweet potatoes, turnips, carrots and yeast.*

The association of managese with vitamins :— Manganese is an essential element in plant economy and performs an important function in the synthesis of chlorophyll. The pericarp and germ of rice, barley and wheat contain considerable Manganese but in the process of polishing and milling the greatest part of this element is removed. It is suggested that a compound of Manganese may be the vital factor removed in the milling of these cereals. Manganese also occurs in greatest quantities in those organs of the animal body, such as the liver, kidney and pancreas, which are richest in vitamins, and a relationship is therefore assumed to exist between this element

*Vitamins and Diabetes ; Chemical Abstracts XVII, No. 11 (June 10, 1923) p. 1987.

and the vital factors contained in animal as well as plant tisues.*

Vegetable and Mineral Salts in Diabetes.

Vegetable and mineral salts are necessary for diabetics. Decoctions of cereals, namely, wheat, barley, gram and bran, are very useful to them.†

Calcium salts have benefited diabetics ‡

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* Chemical Abstracts XVIII. No. 13 (July 10, 1924) p. 2012.

† According to Dr. Labbe of Paris, 1200 to 1500 grams per diem of green vegetables or salads neutralize acids and relieve hunger. Vegetables should be cooked in milk and only slightly seasoned. (*B. M. J. E.* July 22, 1922 p. 13).

‡ According to Max Kahn and Morris H. Kahn, treatment with Calcium Salts reduced a daily minimum output of glucose of 90g. to less than 19g. (The combination of Calcium with various organs appears to influence the glucose production. In the case of the liver, Calcium seems to act as an aid to glycobiosis while the lack of Calcium Salts induced glycogenolysis. (*Chemical Abstracts*, Jan. 20, 1916, p. 223.)

In the *Practitioner* for September, 1910, in a paper entitled "The part played by colloids in Physiology and Pathology." Dr. G. Arbour Stephens writes :—

"How calcium salts act it is of course difficult to say, but they have something to do with the collodial surface tension is, I think, very probable............

"I think we can infer fairly enough that all the vital processes are matters of varying colloidal tensions."

Eggshells, which contain an abundance of these, may be given in powder. I have often tried them with advantage.*

Diabetics need a large allowance of inorganic salts. They lose from their urine more potassium salts than healthy persons, which perhaps accounts for their nervous instability and coma. Rats fed on a diet deficient in inorganic salts developed coma, from which they could be resuscitated by the administration of calcium and potassium phosphate, sodium chloride, and citrates of sodium, iron, calcium and magnesium.†

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* *The need of Caclium.*—Only those adult who use milk and vegetables in abundance secure a sufficient amount of Calcium, while those who eat much meat and get their carbo-hydrates in the form of bread, and potatoes and beer do not. The amonut of Calcium in the diet appears to be related to certain pathological conditions, such as arteriosclerosis. It is proposed to use in bread making Calcium Chloride and a commercial preparation, called 'Calcifarin' made from rye-flour and Calcium Chloride. It is more practical to add Calcium to fine flour than to attempt to persuade the public to adopt whole grain bread. (*Scientific American,* December 5, 1914, p. 460.)

Calcium salts are with difficulty absorbed from the alimentary canal. They should be given therefore with fats, with which they form soaps and are thus easily absorbed.

†In his paper on "Hyperglycæmia and Glycosuria," in

Diabetics are greatly benefited by what the French call "remineralization," which is accomplished by giving decoctions of cereals, namely, wheat, barley, gram, bran and peas as well as of green vegetables and of tubers like potatoes, yams, turnips, as well as of egg-plants and tomatoes.

Fresh Lime or Lemon juice in Diabetes.

Fresh lime or lemon juice is very useful in diabetes, as it not only relieves thirst, but also diminishes the break-down of the fats of the body to which Acetonuria is said to be due. Hence the administration of fresh lime-juice prevents the occurrence of acetonuria. It also contains vitamins useful in diabetes.

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the *B. M. J., March* 8, 1919, Dr. H. J. Hamburger writes:—

"It is known that in cases of diabetes the quantity of Potassium in the urine is greater than with normal persons. This loss of Potassium experienced by the blood plasma must be restored. We now ask ourselves the question whether it would not be efficient to give such patients, besides the customary Sodium carbonate some Potassium carbonate also.

"That the administering of Potassium serves a good purpose is supported by the experience in connexion with the well known oatmeal cure. According to the analysis of

Pickles in Diabetes.*

Pickles made with vinegar only, as in European countries, in which the vegetable tissues become hard and difficult of digestion, are harmful in diabetes. Those prepared by the Indian method with oil, in which the tissues become softened, are not injurious. But then there is one drawback in the extensive use of Indian pickles. They contain large quantities of spices, and so cannot be good for digestion. However, they may be given without spices, with great advantage to diabetics. I have found lime and lemon pickles very useful in treating them.

Burge, 1 Kg. dried oatmeal contains 5 to 6 grams K_2 O against 0·1 to 0·4 per cent. Na_2 O. One thus succeeds in bringing large quantities of K into the body. This is also effected with potato cure of Mosse. Dried potatoes contain per Kg. no less than 20 to 28 grams K_2 O against 0·0 to 0·6 gram Na_2 O. Finally the following fact claims our attention. The ash of the normal pancreatic gland consists to a large extent of potassium phosphate : 100 grams dry ash contain 2 8 grams K_2 O and 0·04 gram CaO. In the pancreas of a diabetic person, however, there is found to be present in 100 grams dry ash only 1·9 grams K_2 O and 0·17 gram CaO Here again K and Ca vary with respect to each other (Stoklassa).

"From all this it may be gathered that the relation betweeen K and Ca plays a part in glycosuria."

* Diabetics require more potassium salts than healthy

Pan-chewing in Diabetes.

Not long ago, not a little sensation was caused by a certain Doctor—not of Medicine—but of Science—giving out as his opinion —not founded on fact or actual observation, but on mere theoretical considerations—that diabetes in Indians was caused by their habit of chewing the *pan* (*Piper Belte*, Linn.). When we take into consideration the millions of men and women in India who are habituated to *pan*-chewing – a habit which has been prevalent in this country from time immemorial—and the number of diabetics bearing no appreciable ratio to the population—we do not find adequate reason to accept the view that this habit plays

persons. Therefore, they should be given vegetables rich in such salts.

"Robin (*Bull de L' Acudde med.*, No. 23 of 1895) recommends the food to be well salted on account of the loss of inorganic salts in diabetes; to supply potassium salts, he advises green vegetables, especially cabbage and endive, and also a weak solution of potassium tolerate to dilute the wine taken at meals; and to counteract the loss of phosphates of magnesium and calcium, he prescribes glycero-phosphates of lime and calcium, he prescribes glycero-phosphates of lime and magnesia. He also recommends bouillon on account of the inorganic salts which it contains., (*B. M. J. Epitome,* 10 August, 1897, p. 23)

any part in the causation of this disease. From the *pan* acting as a stimulus to the flow of saliva and thus helping in the digestion of the carbo-hydrate food-stuffs, this habit is decidedly beneficial in diabetes.

Leguminous Alimentation in Diabetes.

Bovet* has shown the usefulness of leguminous food in many diseases of nutrition, and he considers it also suitable and valuable in diabetes. Leguminous seeds are rich in nitrogen, and hence useful as giving tone to the system. The modern advocate of leguminous regimen in diabetes Dr. Marcel Labbe of Paris, attributes the beneficial results of this diet to the peculiar chemical properties of leguminous albumin and starch, assimilation of which seems to take place under conditions different from those obtaining for cereals.

**Press Med.* May 11th, 1895, and also *B. M. J.* Epitome, Aug. 10, 1895, p. 24.

According to him leguminous vegetables offer the same advantages as Noorden's 'oatmeal cure' when coma threatens. On account of their large protein content they check nitrogen waste, their protein is better borne than that of meat when acidosis is imminent.

The Japanese use very extensively *Soya hispida* or soya-bean as an article of diet. It is a valuable food for diabetics. It is composed almost entirely of nitrogenous and fatty materials and contains practically no carbo-hydrates. A meal of this, as it contains practically no carbohydrates, but is rich in protein and fat, is used in the form of bread for diabetics. Although soya-bean is indigenous to India, it is not so largely used as an article of food in India as it is in Japan.

Soya-bean in diabetes.

Soya-beans may be taken as a vegetable by soaking them for about sixteen hours until the skin can be removed, after which they are boiled in salt water. When the bean is not available, the gruel flour may be used with advantage.

Ground-nut, *mung phali*, is extensively cultivated in many parts of India. But it is not so largely used as an article of diet as it deserves to be. This may be put to the same uses as the Japanese soya-bean in the dietary of diabetics. The ground-nut may be made into cakes or *chapatis* and given to diabetics.

The use of peanuts.

Peanut butter, made by grinding the nut very fine and reducing the mass to a pasty substance and adding salt for flavouring, is an useful article of diet. I believe the use of peanut bread or cakes in diabetes first appeared in this book. It is, therefore, very gratifying to me to learn that Dr. Frank Nicholson has also found it useful in that malady. In the *British Medical Journal* for Jan. 20, 1917, p. 82, he writes :—

I order a bread made of pea-nut flour and casein. This is made for me quite easily in the kitchen of the Hall Royal Infirmary, and my private patients make it quite well at home. It has the advantage of being very nice to the taste, and can be cut readily in slices even as thin bread-and-butter. I have now several private cases that have made the bread twice a week and eaten it regularly for a year or two and they like it.

Receipe :

Pea-nut flour, eight ounces.

Casein, two ounces.

A pinch of salt.

White of egg, twelve ounces.

The white of egg is beaten to a snow, and then the other ingredients (previously lightly mixed)

are slowly added. The bread is baked in a round oven made of tin.*

The use of dals. Several varieties of leguminous seeds, known as *dals*, are used as staple articles of food by Indians.

The meal of gram and several other kinds of *dals* may be put with advantage to the same use in the treatment of diabetes as the meal of soya-bean is in Japan. The meal, known as *besan* in the bazars of Northern India, may be used in a variety of ways in the treatment of diabetes. *Chapati* or bread made of *besan* is well relished by, and is beneficial to, the diabetic patients. In Rajputana and the Punjab *Chapati* of *besan*,

*Ch. Ab. XIV No. 20, Oct. 20, 1920 p. 3101. The nutritive value of peanut flour as a supplement to wheat flour.

The bread containing from 15 to 25 per cent. of peanut flour is very palatable and contains a protein mixture adequate for normal growth at a cost of less than ¼ the cost of proteins derived from animal sources. Peanut flour is made by grinding the press cake obtained as a by—product when shelled peanuts are pressed to produce peanut oil. The pressed cake has been used as a cattle food and fertilizer because its value as a human food has not been understood. The peanut flour contains about 7 per cent. of fat and 50 per cent of proteins, from 4 to 5 times as much as in wheat flour.

mixed with a certain amount of wheaten flour, are prepared and largely used by the people. These are called *missi rotis* (mixed *rotis*, rather *rotis* of mixed flour). These may be used with advantage by diabetics.*

Unfortunately, *besan* is not very largely used in Bengal, where more cases of diabetes are to be met with than in any other province of India. In the cookery of vegetarian Indian, *besan* serves the same purpose as the yolk of an egg does in European cookery. It is mixed with water and made into a paste, into which many fruits, tubers and green vegetables are dipped before being fried. The coating formed of the *besan* protects them from too much singeing or getting overburnt. Very wholesome and platable cakes are also made from *besan*. It is well beaten, and, after being a little fermented, small balls of it are made of the size of filberts. The more is the paste beaten and allowed to be fermented, the lighter and more

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*In the rainy season, in this (Bijnor) district more wheat appears to be eaten than at any other time of the year, very often in the form of *gochni* bread, with about one part in four of pulse—meal ; p : 300 of the Bijnor District Gazeteer. (Allahabad 1879.)

porous the ball. which is used after being fried in *ghee* or oil.

Drawbacks to the use of dals. Dr. Pavy writes :—

" As a drawback to their high nutritive value, the leguminous seeds must be ranked as difficult of digestion. They require prolonged boiling, to render them tender and digestible. They are apt, besides being heavy on the stomach, to occasion flatulence and colic, and the flatus is charged with a considerable quantity of sulphuretted hydrogen, arising from the sulphur which the legumine contains.;"

Pulses are the staple articles of diet of many races and communities inhabiting India, and so they know how to counteract the drawbacks. They cook *dals* with *Papad-khar* (an impure carbonate of soda) which greatly aids in the process of digestion. In a paper on "The proper cooking of *dals*" which I contributed to the *Indian Medical Gazette* of December, 1896, I tried to show how the addition of *Papad-khar* proves useful in cooking them.

Sulphur is useful in alimentary toxæmia.

Hence beneficial action of leguminous alimentation. Flatulence from the use of *dals* is got rid of by adding assafœtida.

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The use of Oleaginous Seeds in Diabetes.

Besides nuts, several oleaginous seeds are useful in diabetes. In this disease, as the skin is often dry and harsh, the administration of seeds which are rich in oil, proves beneficial, on the same principle on which oil-seed cakes are given to cattle and horses to improve the gloss of their skin. Oleaginous seeds are less expensive and more easily digestible than nuts.

The use of sesame.

Seeds of *Sesamum Indicum*, known as sesame, or, in vernacular, *Til*, are very extensively used in a variety of ways by natives of India as an article of food.

Til, used either baked or parched, is a very wholesome food. Husked til is parched and grounded and made into cakes with *besan*, cheese, cream, a little camphor and cardamoms. The delicate aroma of *til* pervades the cakes, which are wholesome and nutritious.

Ground *til* may also be used by being mixed with cocoanut water and *dahi* (curd), to which a little *ghee*, is added. This makes a pleasant drink.

The use of linseed.

Linseed is rich in Vitamins A and B. It may be used as a bread or a porridge with milk. It makes a lighter bread than pure white flour. The oil may also be applied externally to the skin.

The use of Chironji, the seed of Buchania latifolia.

Chironji, the seed of the berry known as *Pial* in Bengal, is very rich in oil and is very palatable and nutritious. It is used as a substitute for almond and is eaten roasted with milk. Regarding the fruit of *Buchania latifolia*, Sir George Watt writes :—

"The *fruit* is eaten by the hill tribes of Central India. Having first pounded them, along with the contained kernels, they dry them in the sun. As required, this is baked into a sort of bread and eaten."—*Dict. Econ. Prod. India,* Vol. I, page 545.

Chironji bread, as prepared above, is given with advantage to the diabetic as a substitute for ordinary bread.

Poppy seeds called posta dana.

Poppy seeds form a valuable article of food of the natives of India. They are largely employed by confectioners, and also in the preparation of curry powders. Parched poppy seeds are very wholesome. The seeds are rich in oil, very nutritious, and hence useful in diabetes.

Cotton seeds as a food for diabetics.

Some of the practitioners of the Greco-Arabic School of medicine prescribe cotton-seeds as a food to the diabetic.

Cotton-seed is given in a variety of ways, such as fried, parched, roasted, or ground into flour and made into bread. The cotton-seed meal contains three times as much digestible protein as the highest grade of wheat flour. Being over-rich in protein, pure cotton-seed meal bread would closely resemble cheese; a combination, however, of cotton seed meal with other recognised bread-stuffs will prove useful.*

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* "Cotton-seed flour contains more than twice as much protein as meat, but little 'kneading principle.' It must be mixed with two parts of wheat flour when intended for baking." *Chem. Abstr.*, for May 20, 1914, pp. 1837-1838.

In my experience, I have noticed the benefit which diabetics derive from the use of fats and oils of all descriptions. The system of treatment may be aptly called oil-cure. Oil should be rubbed on the body, and also administered internally.

The Bread Fruit Tree.

Some seeds which are not oleaginous, may also be given with advantage to diabetics. Principal amongst them is the seed of Jack-fruit (Artocarpus integrifolia), *Kanthal.* Many years ago, my esteemed friend, the late lamented Lieutenant-Colonel K. R. Kirtikar, F. L. S., I. M. S., drew my attention to it. He found it useful in diabetes.

The flour of the bread fruit is similar in composition to that of banana flour. It is deficient in fat, proteins and Vitamins, but on account of its whiteness and consistency is well adapted for making bread and biscuits low in protein for dietary purposes.*

Beverages for the Diabetic.

The diabetic is very thirsty, and so no restriction should be placed on his drinking pure water,

*Chemical Abstracts, Vol. XIX No. 2, p. 362. 20th Jan : 1925

which is of great importance in acidosis. Tea, coffee and cocoa may be allowed in moderation, although it would be better if he could do without them ; for these substances not only contain purin bodies, but often give rise to dyspepsia, nervousness, &c., and thus do harm in diabetes.

Acidulated drinks containing Phosphoric acid, Nitro-hydro-chloric acid, Tartaric acid, or fresh Lemons may be given to assuage thirst.*

Alcoholic beverages in diabetes.

Some are in favour of alcoholic beverages in moderation, while others condemn them *in toto*. Gautier writes :—

"Generous wines and even cognac bring a valuable element of calorification. Alcohol facilitates the digestion of the fats, and in certain cases diminishes the glycosuria and azoturia. But beer

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**Lemonade for diabetics.*—

The following is said to be useful for assuaging the thirst of diabetics :—

Citric acid	...	...	1 gramme.
Glycerine	...	...	50 grammes.
Cognac	...	...	40 grammes.
Distilled water	...	...	500 grammes.

(*Medical Times*, quoted in the *Scientific American* Supplement, No. 1376 of 17th May, 1902.)

ought only to be allowed very occasionally to diabetics by reason of its dextrin."*

Recently, alcohol has been suggested in minute amounts as a food for diabetics. It is said to aid the digestion of fat and is, therefore, recommended as a beverage. In diabetic coma also, according to Dr. Hutchinson.

"The combustion of alcohol in the tissues appears to lessen the destruction of proteids which are the source of the acid poisons that produce the coma."†

* Reasons for the helpful effect of alcoholic beverages in diabetes, states of depression, and convalescence.

W. E. Burge writes in *Science* Vol. XLVIII. pp. 327-8 (for 1918.)

"It is probable that the helpful effect of alcohol in states of depression and convalescence as well as the exhilarating effect on normal subject is due to the stimulation of the liver to an increased output of catalese with resulting increase in oxidation. The conclusion is drawn that the administration of alcohol to diabetics is helpful because it stimulates the liver to an increased output of catalese which is carried by the blood to the tissues where it facilitates the oxidative process with resulting increased oxidation of sugar and decreased acidosis."

† So also Benedict and Torok (Zeits. f. Kl. Med), as a result of clinical experiments, conclude that in many severe cases of diabetes alcohol is of great value, lessening the proteid combustion and diminishing the amounts of "acetone bodies" produce. They recommend its careful prescribing in amounts ranging from one to three ounces

"As it is the only food material free from the special characters of the proteins, the fats, and the carbo hydrates, and is not directly transformed in the body into sugar or into fatty acids, pure alcohol has been employed in the treatment of diabetes mellitus, being given well diluted in small quantities at frequent intervals. Thus an ounce of alcohol, which is the amount contained in about double the quantity of whisky and brandy, would provide 210 calories, and so takes the place of other foodstuffs, especially sugar and fats. Joslin, of Boston, a well-known authority, in a recent discussion of this subject says that although theoretically alcohol might appear to be usefnl in diabetes, practically patients are better without it, and he believes that one of the reasons why diabetics suffer far less commonly in American than in some other countries from neuritis, is the smaller amount of alcohol consumed. It has not been known that alcohol does not prevent or diminish ketones in the urine." (*The Practitioner* for October, 1924, pp. 212-214.)

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daily, noting carefully the effects and controlling the amount used. As contra-indications, they mention albuminuria, nephritis, arteriosclerosis, also diabetes of children. (*J. T. H.*)

But if alcohol is to be given at all, it should be given with great caution. It should be given rather as a medicine than either as a beverage or a food ; and for this purpose, it may be prescribed in the form of a medicated wine, such as the one containing cocaine, which has been found useful in this disease.

Diabetic Patent Foods.

There are in the market many proprietary foods meant for diabetics. These are advertised as being free from starch and sugar.

Diabetics require more fat than protein ; so most of these preparations are not suited to them. Besides, they become stale after sometime, and as these are not manufactured in India, they cannot be used when fresh. For my own part, I do not recommend any of the advertised proprietary foods to Indian diabetics. Moreover, both Hindus and Muhammadans have religious scruples against their use.

The Fasting Treatment of Diabetes.

Of late, in the treatment of diabetes, alimentary rest or Fasting Cure has found great favour

with many physicians. Dr. F. E. Allen of the Rockefeller Institute writes :—

" when the fasting patient has been free from glycosuria for 24 to 48 hours, the next step is to begin feeding very slowly and cautiously. There need not be a fixed programme. It is desirable to individualise the diet to suit the needs of different patients, and various physicians may have personal preferences of their own. The one requirement is that the patient must remain free from both glycosuria and acidosis. Any trace of sugar is the signal for a fast-day, with or without alcohol. The original fast, to clear up the urine in the first place, may be anything from two to ten days, but after that no fast need be longer than one day. The things to be considered in the diet are carbo-hydrate, protein, fat and bulk. Frequently the first thing given after the fast is carbo-hydrate. No distinction may be necessary between different forms of starch, but there are advantages using vegetables, following Joslin's convenient classification on the basis of carbohydrate content. The first day after fasting, the only food may be 200 grams of vegetables of the 5 or 6 per cent. class. This is increased day by

day until a trace of glycosuria appears, which is checked by a fast day. The purpose of such a programme is to learn the carbo-hydrate tolerance, and to clear up the last traces of acidosis. After this carbo-hydrate period, or sometimes in place of it, protein is given. On the first day perhaps one or two eggs are given, and nothing else. More protein, generally as eggs and meat, is added day by day until the patient either shows glycosuria, or reaches a safe protein ration. The purpose here is to learn the protein tolerance, and to cover protein loss as quickly as possible. Fat is somewhat less urgently needed, except in very weak and emaciated patients, and it can be added gradually, as conditions seem to indicate. An element of bulk in the diet is necessary to give the comfortable feeling of fulness and to prevent constipation."

Joslin, of Boston, has standardized the suggestions in Allen's remark :—

Fasting.—Fast until sugar-free. Drink water freely and one cup of tea and a cup of coffee, if desired. If sugar persists after two days of fasting, add, in divided portions, 200 cc. clear meat broth.

Alcohol.—If acidosis (diacetic acid) is present, take 0·5 cc. alcohol per kilogram of body weight daily until acidosis disappears. Alcohol is best given in small doses every three hours.

Carbohydrate Tolerance.—When the twenty-four hour urine is sugar-free, add 150 grams of 5 per cent vegetables and continue to add 5 grams carbo-hydrate daily up to 20 grams, and then 5 grams every other day, passing successively upwards through the 5, 10, and 15 per cent. vegetables, 5 and 10 per cent. fruits, potato, and oatmeal to bread, unless sugar appears or the tolerance reaches 3 grams carbo-hydrate per kilogram body weight.

Protein Tolerance.—When the urine has been sugar-free for two days, add 20 grams of protein (3 eggs) and thereafter 15 grams protein daily in the form of meat until the patient is receiving 1 gram protein per kilogram body weight or if the carbo-hydrate tolerance is zero only ¾ gram per kilogram body weight. Later, if desired, the protein may be raised to 1·5 grams per kilogram body weight.

Fat Tolerance.—While testing the protein tolerance, a small quantity of fat is included in

the eggs and meat given. Add no more fat until the protein reaches 1 gram per kilogram (unless the protein tolerance is below this figure), but then add 23 grams fat daily until the patient ceases to lose weight or receiving over 40 calories per kilogram body weight.

Re-appearance of Sugar.—The return of sugar demands fasting for twenty-four hours or until sugar free. The diet preceeding the re-appearance of sugar is then resumed, except that the carbohydrate should not exceed half the former tolerance, until the urine has been sugar-free for two weeks, and it should not then be increased more than 5 grams per week.

Weekly Fast Days.—Whenever the tolerance is less than 20 grams carbo-hydrate, fasting should be practised one day in seven : when the tolerance is between 20 and 50 grams carbo-hydrate, 5 per cent. vegetables and one-half the usual quantity of protein and fat are allowed upon the fast-day ; when the tolerance is between 50 and 100 grams carbohydrate, the 10 per cent. and 15 per cent. vegetables are added as well. If the tolerance is more than 100 grams carbo-hydrate upon the weekly fast-day, the carbo-hydrate should be halved.

In the *Practitioner* for 1916, Dr. Leyton writes :—

"The long period during which there is a gradual increase in the diet is not always met so philosophically, and my impression is that considerable advantages are gained by having several patients undergoing the treatment in the same ward. The effect is almost like that of trying to hypnotise a man, the process is made extremely simple and rapid; in the same way, if the patient has seen great benefits resulting from the treatment, he is willing to undergo that treatment, even if it necessitates a considerable amount of self-control."

In India, where cases of diabetes are not so acute as in countries of the West, it is not safe to resort to the Fasting treatment without discrimination. The medical practitioners of India should remember the limitations of the Allen Treatment, mentioned by an American physician.

Dr. Thomas W. Edgar, writing in the Special Diabetic number of the *New York Medical Journal* for May 8, 1920, says, regarding the limitation of starvation in *Diabetes Mellitus* that—

"The question of whether or not starvation is a harmless procedure, is best answered by those of us who have observed its unbiased application in numerous cases. Personally I feel that it is a dangerous procedure and should never be indulged in without the supervision of a competent physician accurately its limitations. I have seen patients who had a two per cent. sugar content and acid free urine in whom there suddenly developed an

intense r gressive ketonuria which resulted in coma and de.th * *

Frequent stravation not only reduces the action of secretion to a minimum quantity during resistance, which in this case is carbo-hydrate, but drains the entire body of its glycogen content. This removes all available stimuli which otherwise might cause activity. Aside from this, the caloric power of the organism is reduced in its production of heat and energy. Resistance is lessened; metabolism is weakened; undernutrition invities infection, and tolerance decreases progressively."

The Cocoanut Cure.

The cocoanut tree is the most useful plant that nature has bestowed upon mankind. There are at least a hundred uses to which the different products of this tree can be put. But, without referring to its other economic uses, it is necessary to say that the fruit has not attracted that attention in the treatment of diabetes which its importance demands. The fruit is a perfect food and drink combined. The objections which can be raised against cures by oatmeal, potato, rice or some other carbo-hydrates, cannot be urged against the cocoanut. It contains all the ingredients necessary to maintain a man in health and comfort. In diabetes also, it can be given with safety. The cocoanut water is a very pleasant beverage, beneficial to the diabetic, as it assuages thirst

greatly, being about twenty-five degrees cooler than the atmosphere.

Cocoanut oil is very useful in the treatment of diabetes. The possibilities of the oil are also great. In these days, when it is becoming very difficult to obtain pure and unadulterated *ghee* refined cocoanut oil should be largely used in every household. It is so very nourishing that some have even proposed it as a substitute for cod liver oil in the treatment of tuberculosis.

Cocoanut oil destroys bugs, lice and other insect pests. Bengalis formerly, as a rule, used to rub their bodies with it—a process which acted beneficially by destroying insects. How far the discontinuance of this habit is responsible for some of the diseases to which the young generation of the Bengalis is subject requires investigation at the hands of the medical profession of that province. Cocoanut also enters largely into the confectionary of the Bengalis. But I understand the present generation of educated Bengalis is not so fond of sweets prepared with cocoanut as were their forefathers. Cocoanut may be given to the diabetic as food in a variety of ways. I have tried *chapatis*, cakes, and several other preparations

of it. The nut, finely powdered, with the addition of a little besan and butter, will make fine chapatis, which will keep also for some time. I urge on the medical profession of this country where cocoanut can be had in abundance, and where unfortunately, diabetes causes a large mortality every year, to try the cocoanut cure.

Diabetic Dietary.*

A dietary, somewhat on the following lines, will be found useful for diabetics in India :—

1. *Breakfast.*—As mentioned before there is a larger excretion of sugar in the morning hours than at any other time of the day. So, for break-

*Ch. Ab. XVII. No. 5, (March 10, 1923) p: 808, Balancing the Diabetic Diet.

Basic caloric requirements should be met, normal balance maintained. Ratio of fat to glucose to be kept below the point at which clinically significant ketosis appears.

The diet may be balanced by the following simple procedure : Protein should be equal to O·66 grams per kilogram of body weight.

Carbo-hydrates should be equal to the glucose tolerance minus 55 per cent. of protein. Fat should furnish enough calories to equal the basal caloric needs minus the calories supplied by the protein and carbo-hydrate. The amount of fat must be within limits which will prevent the development of ketonuria and equals 2·5 to 40·g. of fat for 1 g, of available carbo-hydtrate.

fast, carbo-hydrates should be given in moderation, if not totally withheld.

Milk, cocoanut cakes and preparations of *besan* may be given for breakfast. Those who live in provinces where cocoanut can be had in abundance, should take for breakfast cocoanut and its preparations, as far as possible, without sugar. Thus, for beverage, they should drink cocoanut water, and eat cocoanut meal, either raw, fried, or roasted. Groundnut meal, made into *chapatis*, or cakes, is also very beneficial. So are also almond, pistachio nut, *akhrot* and oleaginous seeds.

2. The principal meal of the day, which should be at about 2 or 3 P. M., to consist of rice, *chapatis*, *dal* and vegetable curries. Such fruits as have been mentioned above are to be given to diabetics with their principal meal of the day.

3. For *supper*.—Milk, cocoanut preparations, fruits and green vegetables.

Conclusion.

As I look upon Diabetes Mellitus, in most cases, as a manifestation of alimentary toxæmia, I should treat every individual case on its own merits. It is not necessary to enforce a too rigid

diet, which by producing disgust for food, might make a patient worse.

The senses of taste and smell which are described as the chemical senses—since we become aware of the smell or taste of a thing by contact with it or its vapours—enable us to exercise our judgment in the selection of our food. Substances like salt, sugar and acids possessing a marked flavour, are of great importance in our life. There is no known substitute for salt

In human economy, sugar fulfills a double function, it is a food, and on account of its pleasant taste, an appetizer, So its total withdrawal from the dietary of the diabetic is not sound in principle or beneficial in practice.

The mouth must do its share, hence, the importance of rational mastication. Flavour is the soul of food, for it stimulates the flow of the digestive juices and has, therefore, an appetizing value.

Anything which relieves alimentary toxæmia is bound to be beneficial to the diabetic. Hence the importance of vegetarian dietary and fruits in the treatment of the disease and the restriction, if not the total withdrawal, of meat, alcohol, tea, coffee, cocoa, and also potato.

By some, diabetes is defined to be a disorder of metabolism. Hence, proteids, fats or carbo-hydrates are not properly metabolised. There is great danger from the excessive or exclusive administrations of proteids, some of the acids of which are converted into glucose. Hence resulted the disappointment of those who attempted to cure diabetes by meat diet.

All sorts of fats cannot be given indiscriminately and in large quantities to diabetics for fear of the production of acetonuria.

Carbo-hydrates also may aggravate the disease, if judicious care be not taken in their administration.

Proteids produce putrefaction, carbo-hydrates fermentation, and fats acetonuria. Hence the necessity of giving these foodstuffs in moderate quantities.

The importance of inorganic salts should not be lost sight of in the dieting of the diabetic.

Whether in health or disease, denatured foods should be avoided as far as possible. In diabetes especially, where metabolic processes are always below par, denatured foods act deleteriously on the system. Sugar acts as an irritant, but not

fruits containing sugar. Fats are said to give rise to acetonuria, but oleaginous seeds are found beneficial. This is due to the fact that vitamins are left behind in the seeds in the expression or extraction of the oil from them.

But, above all, the fact should be remembered that it is not so much the quantity of any food which exercises such influence on the disease as the vitamins. For reasons stated before, **foods rich in vitamins should be given to diabetics.**

It should be remembered that, in some cases Diabetes Mellitus appears to be a "**deficiency disease.**"

The fact shuld not be lost sight of that there is the rich man's Diabetes* as well as the poor man's Diabetes. The former results from over-indulgence in food, the latter is a deficiency disease due to a shortage of Vitamins.

In the former case, Venesection has proved useful.

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*Ch. A. XV. 16 (August, 20, 1921) p. 2664. War diet and diabetes.

The advantageous influence of nutrition during the war on the metabolism of many diabetic patients was caused dy the diminution of protein and to the cessation of overnutrition.

GLOSSARY.

Diabetes :—A disease characterized by an excessive flow of urine.

Diabetes Mellitus :—An excessive flow of urine containing sugar. In medical language the word Diabetes is prefixed to certain other words to denote either the increase or diminished rate of flow of urine or increased or diminished quantity of flow of certain important constituents of the blood or urine or to certain characteristic facies *e. g.*, Diabetes Alternans :—A form of diabetes in which the excretion of uric acid varies inveresely to that of the sugar ; Bronzed Diabetes :—Diabetes connected with certain peculiar blood clot patches in the body (hæmachromatosis) ; Diabetes Biliary :—Diabetes connected with certain peculiar yellow patches in the body (Hanot's Disease) ; Diabetes Conjugal :—Diabetes affecting both husband and wife : Diabetes Decipiens :—Diabetes Mellitus with an excessive flow of urine ; Diabetes Insipidus :—A condition in which there is only excessive flow of urine and no sugar ; Diabetes Phloridzen :—

Diabetes that is caused by the administration of a drug called phloridzin ; Diabetic Puncture :— There is a place in the brain which regulates the flow of urine and sugar in it and destruction or disturbance of this place casues diabetes ; Diabetes Renal a form of diabetes due to the abnormal permeability of the kidneys to sugar. So by calling a certain person diabetic is erroneaous or conveys no meaning but for all practical purposes 'diabetes' means diabetes mellitus.

Ductless Glands :—There are certain glands (organ) in the body which have got no canal or duct to pour their contents, which are useful for the human organism, but their contents or products are absorbed, carried and supplied where necessary or to the proper place through blood. There are several of them amongst whom the most important ones whose actions have been understood are, Pituitary (in the brain), Thyroids (a pair of glands in the neck), Parathyroids (several of them near thyroids), Pancreas (or sweet bread lying middle of and inside the abdomen, it has got a duct which gives out a secretion to the digestive canal which secretion helps

to assimilate protien, but there are specialized cells or chambers which give out an internal secretion which is absorbed by the blood and which helps to digest the sugar in the blood and this internal secretion is called Insulin), Adrenalins (a pair of them placed over the kidneys which produce urine, etc. More and more the utility and importance of these ductless glands are coming into existence.

Pathology :—The science of diseases or that part of medicine which explains the nature of diseases, their causes and symptoms.

Glycosuria :—Sugar in the urine.

Pyrexia :—Fever.

Dextrose :—One of the many varieties of sugar derived from fruits.

Glucose :—Fruit sugar particularly derived from grapes.

Fourth Ventricle :—A place inside the brain.

Metabolism :—Chemical change or metamorphosis of nutriment taken inside the body. Human

body is composed of innumerable microscopic cells or chambers of several dimensions and shape whose conditions are always added to or destroyed during the digestion of food. The process which adds to or constructs the cells or repairs them is called in chemistry as Anabolism and the process which destorys them, Katabolism.

Alimentary System :—Organs connected with the assimilation or digestion of food. There is one large tube from the mouth to the anus which breaks, churns and prepares the food in such a way as to be easily absorbed by the blood. Several portions of it have got particular shape for the particular and specialized work that they have got to do and hence have got different names, *e. g.*—Fauces (mouth), Esophagus (gullet), stomach (or the first bag which churns the food and prepares it for digestion), Duodenum (or the second bag where the major portion of the assimilation of fat and protein take place). small intestine (or a very long tube for further absorption of fats and proteins and carbo-hydrates), Caecum (or the fourth bag for storing and transforming the undigested and wagtse products into stool or faeces), Colon (or another

thick long tube for further digestion of food in a very specialized way, that is. the digestion here takes place with the aid of bacteria and not with the aid of juices or enzymes as is the case upto the junction of the small intestine and Caecum), Rectum (or the end of the digestive canal).

Duodenitis :—Inflammation of a particular and most important portion of the digestive tract.

Hepatic :—Pertaining to Liver.

Biochemic :—Pertaining to the chemistry of living tissues.

Toxaemic :—Poisnous.

Hyperglycæmia :—High percentage of sugar in the blood.

Arteriosclerosis :—Hardening of the walls of the arteries.

Nycturia :—Frequency of urine at night.

Ketosis.—See Acidosis.

Ganglions, sympathetic and other nervous plexuses Chakras—six in number described in Medical and Tantrik works of the Hindus.

For an account of them, see the Prize Essay on Hindu Medicine, printed in *Guy's Hospital Gazette* for March and April 1889 by B. D. Basu, as well as the paper on the Anatomy of the Tantras published in the Theosophist for March 1888. Extracts from these papers are given in the Foreword to Ṡiva Samhita published in the Sacred Books of the Hindus, Vol. XV, by Panini Office, Allahabad.